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THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE:

A RETROSPECT
1831–1921

BY

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PREFACE

The Hon. Sir Charles Parsons, as President of the Association in 1919–20, suggested the compilation of this book, and his generosity has made possible its production: the compiler's gratitude is due to him first of all. The General Secretaries of the Association (Professor H. H. Turner and Professor J. L. Myres) have advised at every stage; these and the General Treasurer (Dr. E. H. Griffiths), Sir William Herdman (past General Secretary and President), Sir Oliver Lodge (past President), Mr. T. Sheppard (of the Municipal Museums, Hull), and Mr. F. A. Bellamy (of the University Observatory, Oxford), have very kindly looked over proofs, and all have been generous with suggestions. The names of other helpers are gratefully recorded in the footnote to Chapter VI. Of the numerous published biographies consulted, those by Sir Archibald Geikie on Murchison and A. C. Ramsay, and those by Dr. Leonard Huxley on T. H. Huxley and Hooker, contain notably valuable references to the Association, and the compiler is proud to acknowledge the kindness of these writers, which has emboldened him to quote freely from their pages. He has also to express his sense of the courtesy of the councils and officers of the Royal Society and the Geological Society, the keeper of the Yorkshire Museum (Dr. W. E. Collinge), the Superintendent of Kew Observatory (Dr. Charles Chree), and Mr. E. H. Nichols, in lending photographs.

A complete record of the work of the Association would occupy many volumes and many expert pens; this book aims no higher than to provide a summary review of its activities, with examples.

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The portraits of Brewster, Whewell, Huxley, and Tyndall are from photographs, that of Sedgwick from an engraving, and that of Rayleigh from an engraving from the portrait by Sir George Reid, in the possession of the Royal Society, the Council of which lent them for reproduction. The portraits of Phillips and Murchison were lent by the Council of the Geological Society. The portrait of Harcourt is from a print lent by Dr. W. E. Collinge. The view of Kew Observatory was lent by Dr. Charles Chree, and is reproduced by permission of Mr. E. H. Nichols, who took the photograph. The portraits of Kelvin and Crookes are from photographs by Messrs. Maull & Fox and Mr. Thomas Fall respectively.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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CHAPTER I

FOUNDATION AND OBJECTS

The period of the foundation—Brewster's views on the position of science—The Deutscher Naturforscher Versammlung—Brewster and the Yorkshire Philosophical Society: Phillips and Harcourt—The first meeting: York, 1831—Recollections of early meetings (Brewster: Murchison: Sedgwick: Whewell)—Opposition to the Association.

The Period of the Foundation

The British Association for the Advancement of Science was founded in 1831.

The circumstances of its foundation may be briefly correlated with the history of the time. In 1814 the Peninsular War was brought to a successful issue. Napoleon abdicated, to return in the following year to momentary power, which was finally brought low at Waterloo. The war, in England, had been (as in the present generation) the preoccupation of every man; its aftermath, too, exhibits certain obvious parallels with the circumstances of the present day. The period of

reconstruction was (as it needs must be) protracted, and in England, in certain respects at least, more so than elsewhere. The industrial revolution had brought with it an independent class sentiment among the industrial population on the one hand and the agricultural and landowning classes on the other; the evils associated with the concentration of large industrial communities were intensified by the financial burden and inflation of prices consequent upon the war, and superposed upon all this was the existence of an unrepresentative parliamentary system. Already before 1814 the 'Luddite' bands of workless artisans had attacked factories equipped with labour-saving machinery, which was regarded as the immediate cause of unemployment, and from such incidents alone (apart from other conditions) it may reasonably be assumed that neither labour on the one hand nor the Government on the other would be favourably disposed toward the advancement of applied science. The prevalent distress germinated in 1819 into the cry for parliamentary reform, but thirteen years of struggle passed before the Reform Bill became law (1832).

Class patriotism, then, had succeeded common patriotism—the succession was inevitable in those years no less than a century later—and the representatives of science were no doubt inspired (or infected) by it. In certain directions, as we have said, reconstruction in England lagged behind that in other countries: the advancement of science supplied an instance. From about 1826 onward this state of affairs began to find loud expression through many eminent scientific men of the time.

John Herschel and Playfair were among the first to speak out; Sir Humphry Davy began a book upon the subject, but died (1828) before completing it. Charles Babbage, however, while Lucasian Professor of Mathematics at Cambridge, published (1830) his *Reflexions on the Decline of Science in England*, and this work was dealt with in the *Quarterly Review* by Sir David Brewster,[1] whose article is a review not only of Babbage's book, but of the whole position of science in this country as compared with others.

Brewster's Views on the Position of Science

Brewster was a man capable of strong sympathies and (on required occasion) an ardent champion; and the common literary style of the period was certainly not a medium for understatement. 'The return of the sword to its scabbard,' he wrote, 'seems to have been the signal for one universal effort to recruit exhausted resources, to revive industry and civilisation, and to direct to their proper objects the genius and talent which war had either exhausted in its service or repressed in its desolations. In this rivalry of skill, England alone has hesitated to take a part. Elevated by her warlike triumphs, she seems to have looked with contempt on the less dazzling achievements of her philosophers, and, confiding in her past pre-eminence in the arts, to have calculated too securely on their permanence. Bribed by foreign gold, or flattered by foreign courtesy, her artisans have quitted her

[1] Vol. xliii, pp. 305 *et seq.* The article is unsigned, but its authorship is confirmed in *Home Life of Sir David Brewster* (1869), by Mrs. M. M. Gordon, his daughter, and in other references.

service—her machinery has been exported to distant markets—the inventions of her philosophers, slighted at home, have been eagerly introduced abroad—her scientific institutions have been discouraged and even abolished—the articles which she supplied to other States have been gradually manufactured by themselves; and, one after another, many of the best arts of England have been transferred to other nations. . . . The abolition of the Board of Longitude, the only scientific board in the kingdom, at last proclaimed the mortifying intelligence, that England had renounced by Act of Parliament her patronage, even of the sciences most intimately connected with her naval greatness.'

The existence of such conditions as this sombre picture delineates is scarcely a matter for wonder when the political and economic state of the country is recalled; but Brewster did not blame that solely or even primarily. He hit out all round. He was severe (in a manner that is still not unfamiliar) upon our learned societies, although he admitted that 'persons who are deeply occupied with their own studies and affairs, cannot devote much personal attention to the management of the societies of which they happen to be influential members'; but he rated the Royal and other societies for their failure to press the claims of science upon the Government. He summed up the position of British scientific men in the following words, contrasting it with instances to the contrary drawn from foreign countries, and especially from France: 'There is not at this moment, within the British Isles, a single philosopher, however eminent

have been his services, who bears the lowest title that is given to the lowest benefactor of the nation, or to the humblest servant of the Crown!' This, it might be said, was an accident almost of the moment, although it was so far true that such names as James Watt, who died in 1819, were allowed to go down to posterity without the adornment of a title. And it might have been supposed that an unaffected demand for such recognition was probably not one which would highly commend itself, then or at any time, to those qualified to bestow it; but the position criticised by Brewster was notably remedied within the one or two decades following the foundation of the Association. Our body in later years directly contributed to this state of affairs: thus Fairbairn, in 1861, was offered, but declined, the honour of knighthood in consideration not only of his work as an engineer, but also of his 'able presidency of the British Association.' This instance is by no means isolated.

'There is not a single philosopher'—thus Brewster continues—'who enjoys a pension, or an allowance, or a sinecure, capable of supporting him and his family in the humblest circumstances! There is not a single philosopher who enjoys the favour of his sovereign or the friendship of his ministers!' And thus in a peroration, Brewster sums up the main points of his argument: 'Enough, we trust, has been said to satisfy every lover of his country that the sciences and the arts of England are in a wretched state of depression, and their decline is mainly owing to the ignorance and supineness of the Government; to the injudicious organisation of our scientific boards

and institutions; to the indirect persecution of our scientific and literary men by their exclusion from all the honours of the State; and to the unjust and oppressive tribute which the patent law exacts from inventors.'

A negative attitude of dissatisfaction, unrelieved by any constructive suggestion for improvement, has probably done more harm than good to the advancement of science, in individual instances, from Brewster's day to this; but Brewster's plaint is not open to that charge. The constructive proposal which is his culminating point in the article under notice is that which concerns the present record most nearly:

'. . . Can we behold unmoved the science of England, the vital principle of her arts, struggling for existence, the meek and unarmed victim of political strife? An association of our nobility, clergy, gentry, and philosophers, can alone draw the attention of the sovereign and the nation to this blot upon its fame. Our aristocracy will not decline to resume their proud station as the patrons of genius; and our Boyles, and Cavendishes, and Montagues, and Howards, will not renounce their place in the scientific annals of England. The prelates of our national Church will not refuse to promote that knowledge which is the foundation of pure religion, and those noble inquiries which elevate the mind, and prepare it for its immortal destination.'

The Deutscher Naturforscher Versammlung

It is clear from other passages in the above article that Brewster, like many men of science at the

time, was looking to the Continent for guidance in the task of strengthening the relationship between science and the public interests. And it has to be admitted that the British Association was founded upon a German model. It is therefore a matter of historical concern to observe how closely that model was followed, and to that end to examine in some detail the objects and origin of the model itself. This was the Deutscher Naturforscher Versammlung, upon which an article, written in 1831 by James F. W. Johnston, appears in the *Edinburgh Journal of Science*, N.S. vol. iv. As to the objects of the German society, Johnston writes in terms which almost exactly fit the case of the British Association to this day:

'The first object of these meetings is to promote . . . acquaintance and friendly personal intercourse among men of science; but other great and perhaps more important benefits grow spontaneously out of them. They draw public attention to science and scientific men, and make people inquire concerning both them and their pursuits. They exalt science in general estimation, and with it those who devote themselves to its advancement; and, above all, they spur on the Governments of the different States to examine into and ameliorate the condition of their scientific institutions; and to seek for men of true science to fill the chairs of public instruction. Such and similar benefits have already resulted from the meetings in Germany. Might not similar results in our own country be looked for from a similar institution?'

The German society was originated by Lorenz Oken (1779–1851), who became Professor of Natural

History at Jena in 1807, and later (1827) Professor of Physiology at Munich. In 1817 he started a monthly journal of literature and science, the *Isis*, into which he introduced a political bias which cost him his chair at Jena, and no doubt fomented the suspicion with which (in accordance with their bent) various Government authorities viewed the earlier meetings of the new association. For it was in the *Isis* that Oken first promulgated 'the plan of a great yearly meeting of the cultivators of natural science and medicine, from all parts of the German fatherland.' He was evidently not easily frightened by the discountenance of government authority. Johnston thus describes him: 'Oken is a little man . . . of dark, yet sanguine complexion, and features whose habitual, if not natural, expression is severity and determination. His dark eye and compressed lips have a forbidding and distance-keeping expression, for one can read upon them our own national motto, "Nemo me impune lacessit."' Other scientific workers, it may be surmised, were more timid than he: at any rate the first meeting of the Deutscher Naturforscher Versammlung, which took place at Leipzig in 1822, attracted a company of little more than thirty persons. But the seed germinated, and the plant flourished at successive annual meetings in Halle, Würzburg, Frankfort, and Dresden, while at Munich in 1827 royal patronage helped to dissipate the remains of political suspicion. The society now began to take the shape familiar in the development of the British Association: the members 'began to reckon their numbers by hundreds; and the amount and variety of subjects brought forward at their public

meetings having increased beyond expectation, it was found necessary to break themselves up into sections, of which the botanists, an amiable and enthusiastic race of men, first set the example.'

The next meeting, at Berlin (1828), set the seal upon the success of the movement. The Prussian Government, reversing its previous attitude, undertook the organisation; lavish hospitality was extended to visitors; excursions, fêtes, and concerts appear in the programme. The president was Alexander Humboldt. British science was represented by Charles Babbage. In the following year (1829), at Heidelberg, Tiedemann, from the chair, took a happy view of the position of science in the civilised world: 'Whereas in former times men regarded the inquisition of nature as a pleasant but useless employment, and as a harmless pastime for idle heads, they have of late years become daily more convinced of its influence upon the civilisation and welfare of nations, and the leaders of the public are everywhere bestirring themselves for the erection of establishments to promote its advancement and extension.' Among those who attended this meeting we find Robert Brown, 'of whom,' Johnston writes, 'Agardh said to me, "I believe him to be the greatest botanist of this or any other country."' 'Andrew Duncan, Materia Medica, Edinburgh,' also signed the roll.

How close was the parallel between the German and the subsequently established British Association may be gathered from a few details quoted from Johnston's article already cited. 'It has become now a matter of debate among the cities of Germany, which shall have the honour of receiving

the society at their anniversary. To have the smallest chance, the city desirous of the honour must either be represented by a deputation of members attending the meeting, or must otherwise express to the society, through its president, its desires, its claims, and the efforts it will make for general accommodation.' The inviting deputation is still a yearly feature at meetings of the General Committee of our own Association: on many occasions more than one deputation have entered into competition; on many more, only tactful negotiation beforehand, on the part of officers of the Association, has relieved the General Committee of the invidious necessity of deciding between rival claims.

The notice from which we are quoting, besides summarising the history of the Deutscher Naturforscher Versammlung, deals specifically with the meeting at Hamburg in 1830, when for the first time a place devoid of any local scientific institutions or interests was chosen, and the president was Bartels, the chief burgomaster. In early days, as will be seen later, presidents of the British Association also were commonly connected with the places of meeting where they occupied the chair. Johnston, at Hamburg, came into conflict with the local secretary: 'It is not my intention to say anything harsh of Dr. Fricke [a leading surgeon of the city], but certainly his temper, his manner towards the strangers, and his general conduct in the discharge of his office, showed him to be entirely unfitted for so distinguished and peculiar a charge.' If allowances be made for differences of national temperament, there is a certain familiarity in the following picture of the general meeting-room (we

call it the Reception Room) at Hamburg in 1830: '... I consider it a strong inducement to be early in repairing to the place of meeting, that the scenes which ensue on every fresh arrival may be seen and enjoyed. A man in his travelling-dress walks into the room, and goes straight up to a group on his left, where he recognises a well-known face. A scream of joyful recognition, and a host of loud exclamations, and a mutual behugging and beslobbering with salutations, first on one side of the face and then on the other, with various shaking of hands and other such gestures attract the general attention; and "Who is that?—who is that?" goes from one to another; and then there is a move of the men who know him, or who have heard of and wish to know him, and the rest are beginning to resume their conversation, when a second interruption arises from the entrance of a great man in another science, and another set of men is set on the *qui vive*, and thus perhaps an entire hour may be most delightfully spent in merely looking on, in studying the physiognomy, and in watching the phases of expression and deep interest that pass over the countenances of different individuals by the mere presence and contact of others, votaries of the same branch of study, whom they have hitherto known only by their labours, but whom, though unseen, they have deeply venerated.' The study of physiognomy (always of some interest) appears in another connexion, which is familiar also to this day—and has many a time led the local caricaturist to take cognisance of a British Association meeting—when our narrator pictures the scene at a Hamburg café, where 'at the cry

"Da geht ein Naturforscher" . . . there was a hustling and a justling, a knocking over of chairs and tables, and a scrambling for hats, as everyone hurried to the door to see what the animal was like, and if it walked on two legs or four on its way up the Jungfernstieg.'

The German society at Hamburg transacted a great part of its work in sections, of which there was one for each of the following subjects or groups of subjects: mineralogy; botany; zoology, zootomy, anatomy, and physiology; practical medicine; physics and chemistry; pharmacy. For the rest, there were of course general meetings, and there were visits to various institutions, and excursions in plenty. One British representative writes feelingly of a rough crossing to Heligoland, and the lack of scientific interest which he found in the island.

Our debt to the German model is sufficiently demonstrated by these examples. The German Association now has its headquarters at Leipzig. Its title is the Gesellschaft Deutscher Naturforscher und Ärzte. In the light of recent discussion upon the organisation of our own sections, it is of some interest to observe that the German association is divided into a large but varying number, arranged under a Naturwissenschaftliche and a Medizinische Hauptgruppe.

Brewster and the Yorkshire Philosophical Society: Phillips and Harcourt

There is no reason to doubt (though doubt has been expressed) that Brewster should be regarded

as the prime mover among the founders of the British Association. For though, as we shall presently see, he had collaborators no less active than himself, he claims priority in an article in the *Edinburgh Journal of Science*,[1] N.S. vol. v, 1831, beginning: 'Some months ago it occurred to the editor of this work [himself] that the general interests of science might be greatly promoted by the establishment of a Society of British Cultivators of Science, which should meet annually in some central town in England. He accordingly corresponded with several influential individuals . . .' Among these was John Phillips, the secretary of the Yorkshire Philosophical Society, to whom Brewster had proposed the first practical step towards the foundation of the Association in the following letter:

'Allerby by Melrose, *Feb. 23rd*, 1831.

'DEAR SIR,—I have taken the liberty of writing you on a subject of considerable importance. It is proposed to establish a British Association of Men of Science similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful Sovereigns in that part of Europe. The arrangements for the first meeting are now in progress, and it is contemplated that it shall be held at York as the most central city in the three kingdoms.

'My object in writing to you at present is to beg that you would ascertain if York will furnish the accommodations necessary for so large a meeting,

[1] Not, it may be remarked, the *Edinburgh Philosophical Journal*, as Murchison has it in his *Recollections*.

which might perhaps consist of above 100 individuals—if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town and in the vicinity would be likely to promote its objects.

'The principal objects of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions—to bring the objects of science more before the public eye and to take measures for advancing its interests and accelerating its progress.

'The Society would possess no funds—make no collection and hold no property—the expenses of each Anniversary Meeting being defrayed by the members who are present.

'As these few observations will enable you to form a general opinion of the object in view, I shall only add that the time of meeting which is likely to be most convenient would be about the 18th or 25th July.

'I am, dear Sir, ever most truly yours,

'D. Brewster.'

The Yorkshire Philosophical Society (which still flourishes, having about 500 members) had been founded at York in 1821, 'to promote science in the district by establishing a scientific library, scientific lectures, and by providing scientific apparatus for original research. Its more particular object was to elucidate the geology of Yorkshire.'[1] Brewster had chosen wisely in opening his negotiations with a well-established society

[1] From a pamphlet written and published by William H. Harrison, on *The Founding of the British Association*, London, 1881, in connexion with the jubilee meeting.

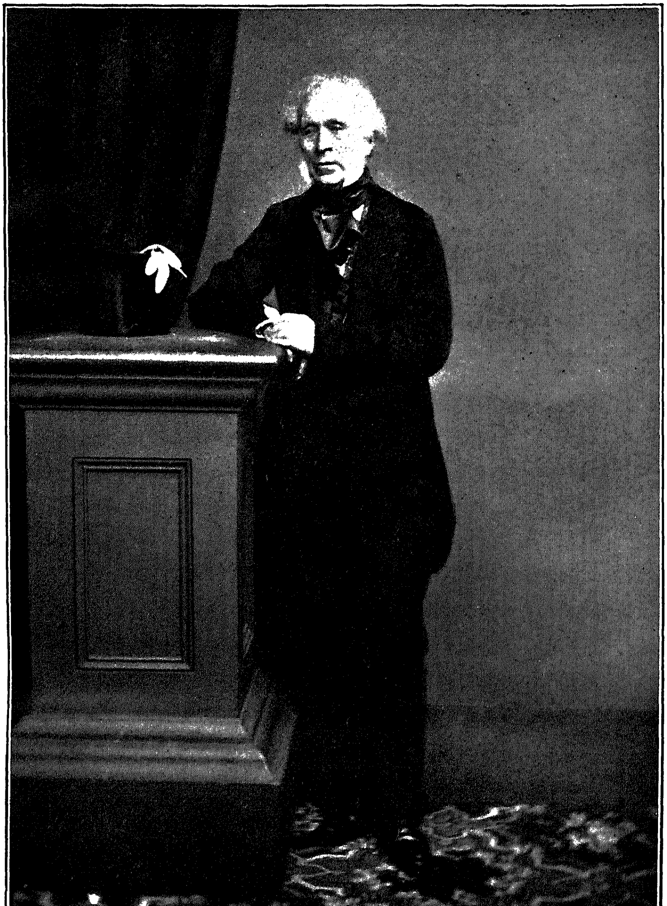
under the guidance of keen officers, who took up his proposals warmly. Harcourt and Phillips moved the council of the Yorkshire Philosophical Society to approach the Corporation of the City of York, with the result that the town clerk wrote to Phillips (March 9, 1831) that the Lord Mayor and some others of the magistrates 'would have great pleasure in doing everything that lies in their power to promote the objects of the Society mentioned by Dr. Brewster, and they rejoice that York is fixed upon as the place for holding its meeting.' The subsequent correspondence which survives, relating to the preliminary organisation of the meeting, is almost wholly between Phillips and John Robison, but James Johnston, who, as we have seen, was acquainted through personal experience with the working of the German association, took a hand, bringing forward various suggestions based upon the practices of that body, which he evidently admired.

The First Meeting: York, 1831

The mother-society of the British Association is the Yorkshire Philosophical Society, for it was in the name of the council of that body that the first public circular calling attention to the proposed meeting 'of the Friends of Science' was issued (July 12, 1831) to other societies and to individual 'cultivators and promoters of science.' A committee of management was formed in York with Harcourt as chairman and Phillips as secretary, and 'the first general meeting took place on the evening of Monday the 26th of September [1831]. It was a

preparatory meeting, but so showy and glittering that a stranger might have thought men had here met together to turn philosophy into sport, rather than to cultivate science in earnest. But it was only the first proof, of which we afterwards received many, of the kindly feelings and hospitality of the people of York, which had induced them on this occasion to assemble—ladies and gentlemen with equal zeal—to do honour to science' (Johnston). It was Phillips, very appropriately, who gave the first scientific address to the Association at this first informal meeting: he spoke extempore on the more noteworthy geological features of Yorkshire, and exhibited specimens. The meeting took on a more formal aspect on the following morning, when, on Brewster's motion, Viscount Milton, President of the Yorkshire Philosophical Society, took the chair. He addressed the assemblage as 'Gentlemen,' and thereby discovered a germ of future disputation; for women were not admitted to the earlier scientific meetings of the Association.[1] Harcourt and Phillips then spoke on the origin and organisation of the meeting, and Harcourt formally proposed the foundation of 'a British Association for the Advancement of Science, having for its objects, to give a stronger impulse and more systematic direction to scientific inquiry, to obtain a greater degree of national attention to the objects of science, and a removal of those disadvantages which impede its progress, and to

[1] This became a burning question. Buckland wrote to Murchison, in connexion with the second meeting: 'Everybody whom I spoke to on the subject agreed that if the meeting is to be of scientific utility, ladies ought not to attend the reading of the papers—especially in a place like Oxford—as it would at once turn the thing into a sort of Albemarle-dilettanti meeting.' See, further, p. 99.



BREWSTER

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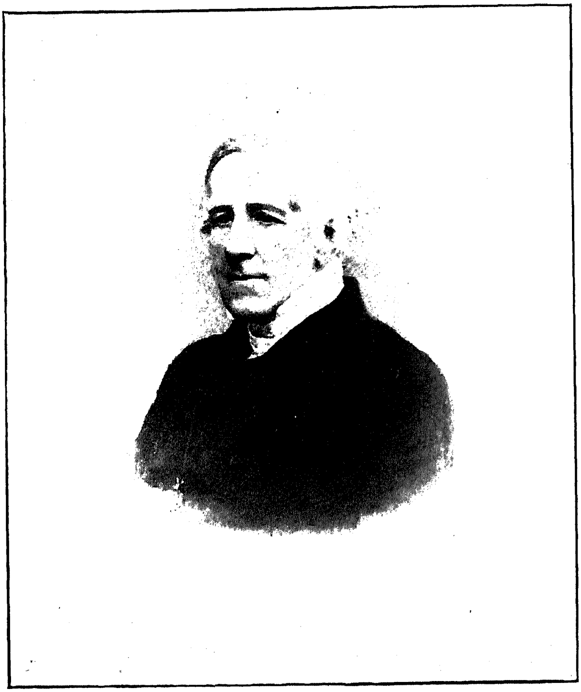

HARCOURT

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promote the intercourse of the cultivators of science with one another, and with foreign philosophers.' He enlarged at length and very eloquently upon the desirability of such a foundation and upon the methods of its working: he followed his address with a series of resolutions (of which the first, giving effect to the foundation, was seconded by Brewster) which laid down the objects and rules of the Association; and he must be regarded as its law-giver. It is appropriate, therefore, to quote with some liberality from his speech, more especially as he gives a clear general idea of the position of science in the British islands at the period:

'. . . Some difference of opinion may exist [he said] . . . as to the want in which we stand of a new Association, to give a stronger impulse and a more systematic direction to scientific inquiry.

'I do not rest my opinion, gentlemen, of this want upon any complaint of the decline of science in England. It would be a strange anomaly if the science of the nation were declining, whilst the general intelligence and prosperity increase. There is good reason, indeed, to regret that it does not make more rapid progress in so favourable a soil, and that its cultivation is not proportionate to the advantages which this country affords, and the immunity from vulgar cares which a mature state of social refinement implies. But, in no other than this relative sense, can I admit science to have declined in England. What three names, if we except the name of Newton, can be shown in any one age of our scientific history which rank higher than those of men whose friendship we have enjoyed, by whose genius we have been warmed, and whose loss it has been our misfortune

prematurely to deplore, the names of Davy, Wollaston, and Young? And there are men still remaining among us, individuals whom I must not mention, present in this meeting, and absent from this meeting, whose names are no less consecrated to immortality than theirs.

'But it is not by counting the great luminaries who may chance to shine in this year or that—in a decade of years, or a generation of men—that we are to inform ourselves of the state of national science. Let us look rather to the numbers engaged, effectually, though less conspicuously, in adding by degrees to our knowledge of nature; let us look to the increase of scientific transactions and journals; let us look, gentlemen, at the list produced this day of Philosophical Societies which have grown up in all parts of the kingdom. The multiplication of these new and numerous institutions indicates a wide extension of scientific pursuits. The funds so liberally contributed to their support bear evidence of an enlarged disposition in the public to promote such pursuits.

'It is on this very ground I rest the necessity and the practicability of establishing in science a new and impulsive directive force, that there are new and more abundant materials to be directed and impelled. . . .

'I am not aware, gentlemen, that in executing such a plan we should intrude upon the province of any other institution. There is no society at present existing among us which undertakes to lend any guidance to the individual efforts of its members, and there is none, perhaps, which can undertake it. Consider the differences, gentlemen, between the limited circle of any of our scientific councils, or even

the annual meetings of our Societies, and a meeting at which all the sciences of these kingdoms should be convened, which should be attended, as this first meeting you see already promises, by deputations from every other Society and in which foreign talent and character should be tempted to mingle with our own. With what a momentum would such an Association urge on its purpose! What activity would it be capable of exciting! How powerfully would it attract and stimulate those minds which either thirst for reputation or rejoice in the light and sunshine of truth!

'The Royal Society still embodies in its list every name which stands high in British science; it still communicates to the world the most important of our discoveries, it still crowns with the most coveted honours the ambition of successful talent, and when the public service requires the aid of philosophy, it still renders to the nation the ablest assistance and the soundest counsel. Nevertheless, it must be admitted, gentlemen, that the Royal Society no longer performs the part of promoting natural knowledge by any such exertions as those which we now propose to revive. As a body, it scarcely labours itself, and does not attempt to guide the labours of others.

'Hence it happens that when any science becomes popular, and those who interest themselves in its advancement perceive the necessity of working for it by united exertions, that science is detached from the central body; first one fragment falls off, and then another; colony after colony dissevers itself from the declining empire, and by degrees the commonwealth of science is dissolved. The new societies distinguish themselves by their diligence

and activity; the parts of knowledge which thus receive more distinct attention, and are propelled by more undivided labour, make rapid advances; and each separate undertaking justifies itself by the most promising appearances and undeniable fruits.

'This is a new stage, gentlemen, in the progress of science; a new state of things which, whilst it is attended certainly with great advantages, has some consequences of doubtful aspect to the highest aims of philosophy. As the facts and speculations in any department of knowledge are multiplied, the study of it has a tendency to engross and confine the views of those by whom it is cultivated; and if the system of separate societies shall encourage this institution, science will be in the end retarded by them more than it is at first advanced. The chief interpreters of nature have always been those who grasped the widest field of inquiry, who have listened with the most universal curiosity to all information, and felt an interest in every question which the one great system of nature presents. Nothing, I think, could be a more disastrous event for the sciences than that one of them should be in any manner dissociated from another, and nothing can conduce more to prevent that dissociation than the bringing into mutual contact men who have exercised great and equal powers of mind upon different pursuits; nothing more fitted to shame men out of that unphilosophical contempt which they are too apt to feel for each other's objects; nothing more likely to open to them new veins of thought, which may be of the utmost importance to the very inquiries on which they are more peculiarly intent. . . .

'There is a defect in these separate societies, in respect to their own immediate objects, which I am

sure no member of them would wish to dissemble, and which arises from the narrow basis on which they are of necessity built. It is not only that the constant converse of men, who, to borrow the expression of Goldsmith, have often travelled over each other's minds, is not half so effectual in striking out great and unexpected lights, as the occasional intercourse of those who have studied nature at a distance from each other, under various circumstances and in different views; but it is also, gentlemen, that none of our existing Societies is able to concentrate the scattered forces even of its own science; they do not know, much less can they connect and employ, that extensive and growing body of humble labourers who are ready, whenever they shall be called upon, to render their assistance. . . .

'Scientific knowledge has of late years been more largely infused into the education of every class of society, and the time seems to be arrived for taking advantage of the intellectual improvement of the nation. Let Philosophy at length come forth and show herself in public; let her hold her court in different parts of her dominions; and you will see her surrounded by loyal retainers, who will derive new light and zeal from her presence and contribute to extend her power on every side. . . .

'But even the experienced in science will benefit by consultation with each other; for there are different degrees of experience, and no solitary industry or talent can ever hope to equal the power of combined wisdom and concerted labour. Above all, consider, gentlemen, the excitement to exertion which will be felt by those who are solicited to undertake an inquiry at one of these meetings, and pledged to produce the investigations at another.

The greatest minds require to be urged by outward impulses, and there is no impulse more powerful than that which is exercised by publicly esteemed bodies of men. Even Newton's papers might have remained unfinished, but for the incentive of such a solicitation. In a letter which I have lately received from Mr. Conybeare, and in which he expresses a deep regret at finding himself unexpectedly prevented from attending this meeting, the benefit in these respects which may be looked for from a general scientific combination is described with the energy of his ardent and comprehensive genius. "Your proposal," he says, "for ingrafting on the annual reunion of scientific men, a system of effecting such a concentration of the talent of the country as might tend more effectually to consolidate and combine its scattered powers, to direct its investigations to the points which an extensive survey thus generalised would indicate as the most important—benefited by all the aids which the union of powerful minds, the enlarged comparison of different views, and a general system of intellectual co-operation could not fail to afford, fills me with visions too extensive almost to allow me to write with sufficient calmness of approbation. The combined advantages, including at once the most powerful stimulus and the most efficient guidance of scientific research, which might emanate from such a point of central union seem to me to be beyond calculation. If views like those you have sketched could be realised, they would almost give a local habitation and a name to the philosophical academy of Bacon's Atlantis, when 'divers meetings and consults' of the united body of Depredators, Compilers, Pioneers, etc., suggested new experiments of a higher light and more penetrating

nature to the lamps, and these at length yielded materials to the interpreters of nature."

'To that great model of a national Institution for the advancement of science I have already adverted to-day, as I have formerly directed to it the attention of the Yorkshire Philosophical Society; it is here referred to by Mr. Conybeare, and by a remarkable coincidence of ideas we have the same reference from Mr. Harvey, who in a letter from Plymouth, which he has addressed to the Secretary of the meeting, observes, that "Bacon alludes to circuits or visits of divers principal cities of the kingdom as forming a distinguished feature of the New Atlantis. What Bacon," he adds, "foresaw in distant perspective, it has been reserved to our day to realise, and as his prophetic spirit pointed out the splendid consequences that would result generally from institutions of this kind, so may we hope that the new visions which are opening before us may be productive of still greater effects than have yet been beheld, and that the bringing together the cultivators of science from the North and the South, the East and the West, may fulfil all the anticipations of one of the greatest minds that ever threw glory on our intellectual nature. . . ."

'We propose that all members of Philosophical Societies in the British Empire shall be entitled to become members of the Association, on enrolling their names, and engaging to pay such subscription as may be agreed upon, the amount of which subscription, we think, ought to be low; and we propose that the members shall meet for one week in every year at different places in rotation; in order by these migratory visits to extend the sphere of the Association, to meet the convenience of distant districts in

turn, and to animate the spirit of philosophy in all the places through which the meetings may move, without rendering them burthensome to any.

'But the governing or executive power of the Association, we think, should be vested in a more select, though still numerous body, and placed in the hands of those who appear to have been actually employed in working for science. We propose, therefore, that the General Committee shall consist of all members present at a meeting who have contributed a paper to any Philosophical Society, which paper has been printed by its order, or with its concurrence; taking this as the safest definition of the class of persons intended, but leaving power to the Committee to add to its own number, and to admit into the Association other members at its own discretion; and we propose that it shall sit during the time of the meeting, or longer if necessary, to regulate the general affairs of the Association, to manage the business of the session, and to settle the principal scientific arrangements for the ensuing meeting.

'We recommend, however, that these arrangements should be first digested, and the particular advancement of every science specially looked to by Sub-committees, which the General Committee shall appoint, placing severally on each those members who are most conversant with the several branches of science. We propose that the Sub-committees should select the points in each science which most call for inquiry, and endeavour, under the authority of the General Committee, to engage competent persons to investigate them; that where the subject admits of the co-operation of scientific bodies, the Sub-committees should recommend application to be made for that assistance; and that they should

attend especially to the important object of obtaining reports in which confidence may be placed, on the recent progress, the actual state, and the deficiencies of every department of science.

'On the last of these points I beg leave to quote the opinion of an able and zealous philosopher, the Professor of Mineralogy at Cambridge, who has been prevented by his public duties at the University from attending the meeting, but who nevertheless takes the deepest interest in its objects. A collection of reports, says Professor Whewell, concerning the present state of science, drawn up by competent persons, is on all accounts much wanted; in order that scientific students may know where to begin their labours, and in order that those who pursue one branch of science may know how to communicate with the inquirer in another. For want of this knowledge we perpetually find speculations published which show the greatest ignorance of what has been done and written on the subjects to which they refer, and which must give a very unfavourable impression of our acquirements to well-informed foreigners. . . .

'It is evident that if the plan which I have thus far explained should be carried into effect, the deliberations of the Committee to be formed at the present meeting will provide the chief materials for the considerations of the next. Those investigations and those surveys of science which shall have been suggested and procured by the committees and officers of the Association will be entitled to the priority, though other communications may be accepted as far as the duration of the session will allow. Professor Whewell conceives "that if this meeting were to request from one or two among the most eminent men in the various branches of science,

statements to be presented next year of the advances made in each department, and the subjects of research which they consider at present the most important and promising, such a request would be respectfully attended to." Gentlemen, I do not doubt that it would; neither do I doubt that a simple request from this meeting would be successful in procuring new researches to be made; and should the funds of the Association hereafter admit of its going further, and offering prizes for particular investigations, then would another prolific source be opened from which the scientific materials of our meetings would be derived.

'This, indeed, would only be another, and a very powerful, method of carrying on the system which we recommend of advancing science in determinate lines of direction. . . .

'An enterprise like this has no danger to fear, but from a deficiency of zeal and union in carrying it into effect. It must undoubtedly fail if it meets only with imperfect co-operation and cold support. But if it shall recommend itself to the full approbation of men of science, if it appears to you, gentlemen, desirable to undertake it the Association will have competent sponsors in the present assembly, who will stand pledged not only for its early encouragement, but for those future exertions which will be required to ensure its success. The council of the Yorkshire Philosophical Society have not the presumption to dictate to this meeting the course which it may be for the interests of philosophy to pursue. They collected, in the first instance, the best opinions which they could obtain, before they proceeded to mature their plan, and they now wait for the opinion of the eminent persons who are here assembled, before they

can assure themselves that it is as feasible in practice as it appears in theory.'

It will be seen from one of the above paragraphs that the government of the Association was conceived on the broadest lines to be in the hands of a General Committee, for service upon which any member should be eligible who, as the present rule lays down, 'by the publication of works or papers' has 'furthered the advancement of knowledge in any of those departments which are assigned to the sections of the Association.' This wise though not difficult qualification, together with membership under certain conditions *ex officio*, has given the General Committee a roll of some 700 names at the present day, and at the outset it was clear that a body so constituted could not be expected to deal with details of administration. In 1832, therefore, the General Committee constituted the Council, a less unwieldy body, to discharge administrative functions, while the General Committee exercises powers of supervision and legislation. It is an ingenious development of later years that while the General Committee appoints the Council, the Council admits members to the General Committee.

Recollections of Early Meetings (Brewster: Murchison: Sedgwick: Whewell)

When Brewster, in 1850, looked back upon the birth and early years of the Association from its presidential chair, he spoke as follows: 'Sir John Robison, Professor Johnston, and Professor J. D. Forbes were the earliest friends and promoters of the British Association. They went to York to

assist in its establishment, and they found there the very men who were qualified to foster and organise it. The Rev. Mr. Vernon Harcourt, whose name cannot be mentioned here without the expression of our admiration and gratitude, had provided laws for its government, and, along with Mr. Phillips, the oldest and most valuable of our office-bearers, had made all those arrangements by which its success was ensured. Headed by Sir Roderick Murchison, one of the very earliest and most active advocates of the Association, there assembled at York about 200 of the friends of science. Dalton, Pritchard, Greenough, Scoresby, William Smith, Sir Thomas Brisbane, Dr. Daubeny, Dr. B. Lloyd, Provost of Trinity College, Dublin, Professor Potter, Lord Fitzwilliam, and Lord Morpeth took an active part in its proceedings ; and so great was the interest which they excited that Dr. Daubeny ventured to invite the Association to hold its second meeting at Oxford. Here it received the valuable co-operation of Dr. Buckland, Professor Powell, and the other distinguished men who adorn that seat of literature and science. Cambridge sent us her constellation of philosophers—bright with stars of the first magnitude—Whewell, Peacock, Sedgwick, Airy, Herschel, Babbage, Lubbock, Challis, Kelland, and Hopkins ; while the metropolitan institutions were represented by Colonel Sabine, one of our general secretaries ; Mr. Taylor, our treasurer ; Sir Charles Lyell, Colonel Sykes, Mr. Brown, Mr. Faraday, Professors Owen and Wheatstone, Dr. Mantell, Lord Northampton, Lord Wrottesley, Sir Philip Egerton, and Sir Charles Lemon. From Ireland we have received the distinguished aid of Lord Rosse, Lord Enniskillen,

Lord Adare, Dr. Robinson, Dr. Lloyd, Sir William Hamilton, and Professor MacCullagh; and men of immortal names were attracted from the continents of Europe and America—Arago, Bessel, Struve, Liebig, Jacobi, Leverrier, Encke, Ermann, Kupffer, Ehrenberg, Matteucci, Rogers, Bache, and Agassiz.'

Murchison was a trustee of the Association from 1832 to 1870, a general secretary from 1836 to 1845, and president in 1846. He is, therefore, one of the best authorities for the early history of the Association, and in the following paragraphs we quote freely from the memoir of him by Sir Archibald Geikie (1875). From York, towards the close of the first meeting, he wrote thus to Whewell; 'Before I entered into the "British Association" which the meeting at York has given rise to, I was very desirous of weighing the men who were eventually to carry us through. I was really very mainly induced to join it in consequence of your letter to William Vernon [Harcourt], and I was quite decided in doing so when I saw the calibre of the men he had assembled, and the promise of support from those who could not attend. . . . Brewster really astonished everyone with the brilliancy of his new lights, old Dalton, "atomic Dalton," reading his own memoirs, and replying with straightforward pertinacity to every objection in the highly instructive conversations which followed each paper. . . . I had no memoir ready myself, and did not intend to rob the Geological Society of anything intended for them, but I found that a poor and hard-worked druggist of Preston,[1]

[1] Mr. W. Gilbertson (see *Brit. Assoc. Rep.*, 1831–2, p. 82). The shells referred to are in the Geological Museum, Jermyn Street, London.

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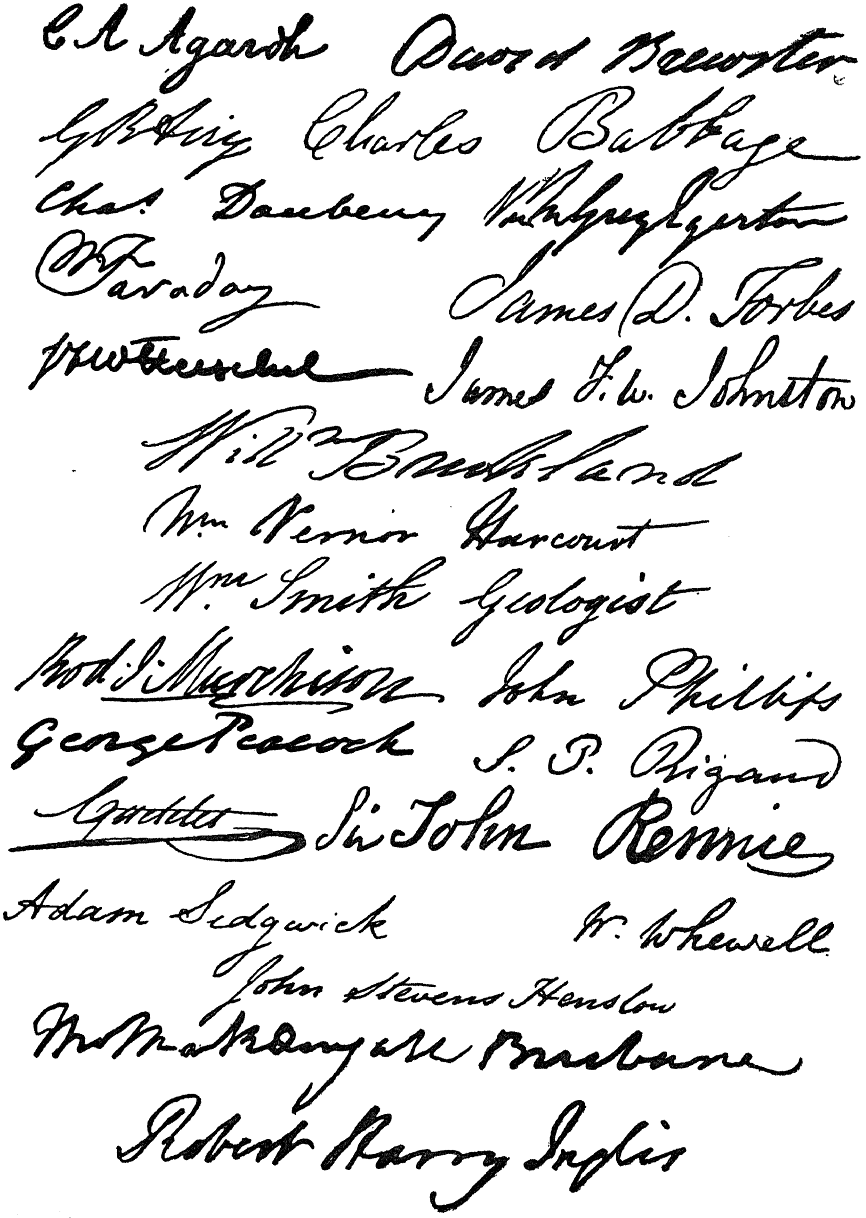
Lancashire, who had made some years ago a very important observation on the existence of shells of existing species in the gravels and marls of Lancashire at 300 feet above the sea, and at distances of fifteen and twenty miles from the sea, was present. I took the opportunity of turning lecturer, and having visited those parts this summer, I brought out my little druggist with all the *éclat* he merited. This is another practical exemplification of the good arising from such a reunion. The Archbishop had all the party on one of the days, and it would have gratified the liberality of Cambridge to have seen old Quaker Dalton on his Grace's right hand. Pray act cordially with us, and if Adam [Sedgwick], my great master, and yourself will only go along with us, the third meeting will unquestionably be at Cambridge. Rely on it, the thing must progress, all the good men and true here present are resolved to make it do so.'

Of the following meeting Murchison wrote thus in his journal: 'The summer of 1832 was begun with the Oxford meeting of the British Association, and of this I need say nothing more than that, under the presidency of Buckland, the body was then licked into shape, and divided into six sections. As the mass of the great guns of the metropolis had now joined us, and also Sedgwick, Whewell, and the best men of Cambridge, our success was assured. Altogether it was (thanks to its proposer, Daubeny) a most auspicious meeting, the more so as it terminated with an invitation for the next year from Cambridge, with my dear colleague, Adam Sedgwick, as *praeses*.'

The meetings of 1834 and 1835 were appropriately held in Scotland (Edinburgh) and Ireland (Dublin), following upon the two first meetings in



Signatures (reduced) from a collection made at the Cambridge Meeting, 1833.

England. In connexion with the Irish meeting a picturesque story is vividly told in Sedgwick's 'Life and Letters,' how, going from Liverpool to Dublin by a special steamer detailed for the service of the Association, he was called upon to baptise the infant son of the captain on board; how the congregation assembled to the sound of a newly invented bell-buoy which the vessel was just then passing; and how Sedgwick was moved by the occasion to a wonderful address on the aims of science toward divine truth. The second Irish meeting, at Cork in 1843, was far less successful than the first: the state of southern Ireland was at the time so unsettled that Murchison was in serious doubt as to the safety of holding a meeting there; and the local arrangements were indifferent, so that Murchison declared that 'we never were so near shipwreck as at this Cork meeting.'

The majority of the leaders in the Association's counsels at this period were in favour of restricting the circuit of summer annual meetings to places where a sufficiency of scientific support could be relied upon, but this policy was opposed by no less weighty an authority than Whewell. He advocated an extended range: he wished the light of science to be distributed as widely as possible through the benighted provinces; and he feared that any town visited at too frequent intervals might take alarm at the expense incurred in connexion with the meetings. Thus with reference to the proposal that a second meeting should be held at Cambridge in 1845, an animated debate took place there in the previous year, at which Whewell and Sedgwick were protagonists. Sedgwick went the length of inviting the

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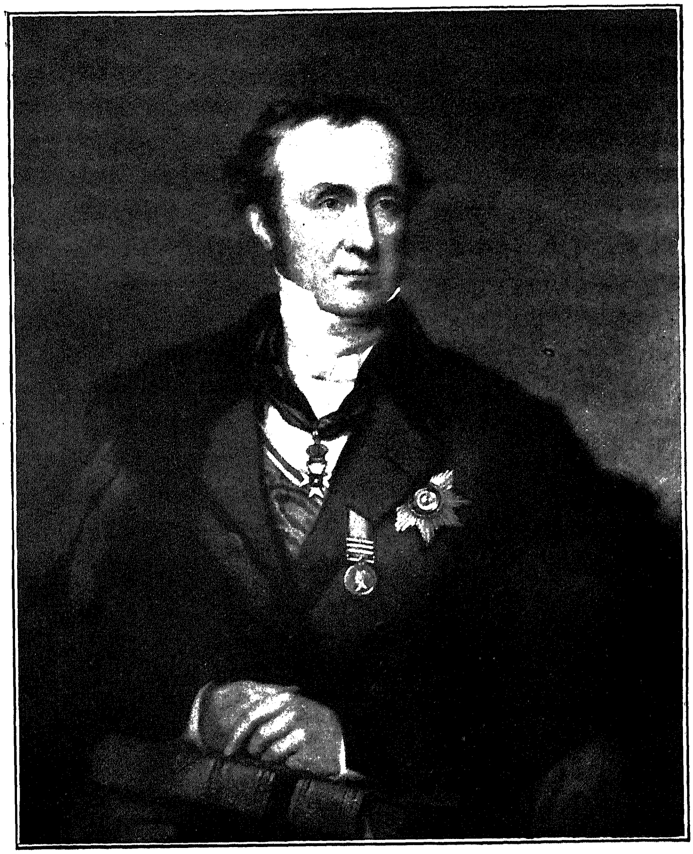

MURCHISON

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Master of Trinity, if he could not welcome the Association, at least to remain passive and 'shut himself up in his lodge.' He alleviated the sting of this onslaught, however, in the remainder of his speech, and Whewell, further persuaded by a long letter from Murchison, allowed himself to be overruled, though he held no office during the meeting. Nor did he change his views, for as late as 1862 he commented adversely upon the Association's decision to meet at Newcastle-on-Tyne in the following year. 'I think it is better,' he wrote, 'to go to new places; Bath and Dundee urged their claims, and I do not like to have the thoughts of men of science turned mainly to war, as is done by making Sir W. Armstrong the President.' But he had by this time recognised the material advantage of meeting in a wealthy centre, for he added, 'The Association wants money, and ought to get it, for it spends a great deal.' And Armstrong's address, it is fair to record, contained but two short paragraphs on gunnery.

Opposition to the Association

It is not to be supposed that there was no opposition to the establishment of the Association: there was plenty. Reverting for a moment to the first meeting at York, we may note that Murchison thus recalls this attitude, and incidentally gives a rather less favourable view of the meeting itself than that which he conveyed to Whewell: 'The project . . . having been transmitted to me in London in the spring of 1831, when I was President of the Geological Society, I at once eagerly supported it. Nay, more, I wrote and lithographed an appeal to all my

scientific friends . . . urging them to join this new Association. But notwithstanding my energy, the scheme was for the most part pooh-poohed. . . . When . . . we were congregated from all parts, the feebleness of the body scientific was too apparent. From London we had no strong men of other branches of science, and I was but a young president of the geologists; from Cambridge no one, but apologies from Whewell, Sedgwick, and others; from Oxford we had Daubeny only, with apologies from Buckland and others. . . . We were but a meagre squad to represent British science. . . .

'Indeed, William Conybeare, afterwards Dean of Llandaff, had quizzed us unmercifully, as well as W. Broderip and Stokes, and other men of science. The first of these had said that if a central part of England were chosen for the meeting, and the science of London and the South were to be weighed against the science of the North, the meeting ought to be held in the Zoological Gardens of the Regent's Park! It required, therefore, no little pluck to fight up against all this opposition. . . .'

Murchison's biographer adds the following note to the above quotation: 'As an illustration of the kind of taunts amid which the British Association was born, the following sentence may be quoted from a letter written by J. G. Lockhart, editor of the *Quarterly Review*, to Murchison just before the meeting: "I presume you are going to the colt-show at York. Don't make a fool of yourself among these twaddlers, who must, in such strength of reunion (considering what happens in all their minor associations), be enough to disturb the temper, if not the brains of the *σοφώτατοι*, of which number is, of

course, the P.G.S.L."' (*i.e.* the president of the Geological Society of London—Murchison himself).

A few years later the Association came under fire from the pen of Charles Dickens. In 1837–39 he wrote for *Bentley's Miscellany* a series of contributions subsequently collected as the *Mudfog Papers*, and in two of these he dealt trenchantly with the first and second meetings of 'the Mudfog Association for the Advancement of Everything.' Herein we may read of the doings and sayings of Professors Snore, Doze, and Wheezy; Messrs. Muddlebranes and Drawley, Rummun and Pumpkinskull, and many other such, duly set forth in sectional transactions, in which the sections of Zoology and Botany, Anatomy, Statistics and the rest are followed by that of Umbugology and Ditchwaterisics, and the whole is served up with a spice of humour of characteristic flavour, if possibly, to present taste, rather crude.

Looking forward a little, we find that this class of opposition persisted for some years after the Association had well established itself. Murchison's biographer refers as follows to this opposition, indicating its rather flimsy basis, and incidentally revealing what might have been interpreted as a singularly ingenuous piece of journalistic touting for advertisement:

'The British Association was now fifteen years old. It had come through its infancy so well that there could be no doubt of its vigorous growth. Nevertheless, some of its early detractors continued their opposition, to which piquancy was given by the various ways in which derision and contempt could be expressed. Among these persistent enemies,

the most conspicuous and formidable was *The Times* newspaper, which had followed the Association with the most uncompromising hostility, refusing at last to print the lucubrations of the philosophers unless inserted as advertisements, but continuing its sneering paragraphs or contemptuous articles. Some of the maligned body felt this keenly. They could not realise that they had really a ludicrous side; that their feasting and holiday-making, their frequent mutual laudation, and, above all, the opening which their meetings afforded for any hobby-rider to air his crotchets, were features which could not but strike the non-scientific outsider, who, if he could not appreciate the science, might not unnaturally form but a poor estimate of the usefulness of the Association. No one of the members winced more under these attacks than Murchison. Once or twice, indeed, he had written to an editor either to protest against the spirit of his remarks, or to correct some error in a statement of fact. Somehow the Southampton meeting [1846—the year of Murchison's presidency] had evoked a renewed outburst on the part of *The Times*. "Notwithstanding all my efforts and those of my associates," Murchison remarks in his journal, "the meeting was held up to ridicule in *The Times*. But I was nothing cowed, and at the public dinner at Southampton I declaimed against such ribald vulgarity and ignorance, saying I was ashamed my eminent foreign friends should go away with the impression that *The Times* in its vituperation of science represented my country, and I vehemently declared that *tempora mutabuntur*. Afterwards, when visiting at Broadlands, I was complaining to Lord Palmerston of the injustice of such treatment. 'Pooh, pooh!' said he. 'Never mind

them; a man who is not *Times*-proof cannot succeed in life!' " '

Edward Forbes, a strong supporter of the Association, and with his peculiar breadth of interest a particularly useful recruiting-sergeant for its membership list, forcibly observed, with reference to this same meeting (1846), that 'the Association never gained more friends than through this campaign of *The Times*, conducted by a jesting puppet, whose strings were pulled by sneering and pseudo-scientific humbugs.'

It is fair (if scarcely necessary) to add that in later years *The Times* made the *amende*, and that the Association has become one of those public institutions the reports of whose proceedings are recognised by the Press generally as necessary to the information of the public. It is perhaps no matter for wonder that individual authors of communications to the Association are at times disconcerted at the scanty measure or doubtful accuracy of Press notices accorded to their work: to the layman, on the other hand, it is rather a point worthy of admiration that the representatives of daily newspapers should handle the complex and frequently unfamiliar subject-matter of an Association meeting with the degree of efficiency which they now attain. And their criticism of the functioning of the Association as a public body has not infrequently been pertinent: not least so that of *The Times* itself.

Though records are none too numerous, we need not quote Murchison as the Association's sole champion against its detractors. Lyell,[1] indeed, after the Newcastle meeting in 1838, wrote: 'All that I saw

[1] *Life, Letters, and Journals of Sir Charles Lyell, Bart.*, edited by his sister-in-law, Mrs. Lyell. London, 1881.

of the government of the Association gave me a good idea of the spirit, but no wish to consume my time in taking a part in it.' Nevertheless, despite his personal taste, he wrote later in the same year to Charles Darwin:

'Do not let Broderip, or *The Times*, or the *Age*, or *John Bull*, nor any papers, whether of saints or sinners, induce you to join in running down the British Association. I do not mean to insinuate that you ever did so, but I have myself often seen its faults in a strong light, and am aware of what may be urged against philosophers turning public orators, etc. But I am convinced, although it is not the way I love to spend my own time, that in this country no importance is attached to any body of men who do not make occasional demonstration of their strength in public meetings. It is a country where, as Tom Moore justly complained, a most exaggerated importance is attached to the faculty of thinking on your legs, and where, as Dan O'Connell well knows, nothing is to be got in the way of homage or influence, or even a fair share of power, without agitation. . . . I can also assure you, as the strongest commendation, that the illiberal party cannot conceal their dislike, and in some degree their fear, of the growing strength of the Association. . . . Heaven be praised, we seemed in no danger of splitting on the rock of politics, which I always fear much more than any occasional squabbles among ourselves. . . . The moral of all this is, Go next year to Birmingham if you can, although your adviser has been only to two out of eight meetings.'

Again, of the Oxford meeting in 1847, Lyell, in describing events to his father at some length, says:

'Out of twenty-four heads of houses, only four at Oxford to receive the Association! But it will go off the better by the absence of the lukewarm or the hostile.'[1] It is no matter for wonder that Oxford, not only at the time of Lyell's comment, but both before and after, should have contained notable elements of disaffection. The deeper causes of this were appropriately summarised by the Marquis of Salisbury from the chair when the Association met, again at Oxford, in 1894; he said:

'I have the consolation of feeling that I am free from some of the anxieties which have fallen to those who have preceded me as presidents in this city. The relations of the Association and the University are those of entire sympathy and good will, as becomes common workers in the sacred cause of diffusing enlightenment and knowledge. But we must admit that it was not always so. A curious record of a very different state of feeling came to light last year in the interesting biography of Dr. Pusey, which is the posthumous work of Canon Liddon. In it is related the first visit of the Association to Oxford in 1832. Mr. Keble, at that time a leader of University thought, writes indignantly to his friend to complain that the honorary degree of D.C.L. had been bestowed upon some of the most distinguished members of the Association: "The Oxford Doctors," he says, "have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did." It is amusing at this distance of time to note

[1] As recording an interesting incident which finds no place in the general history of the Association, two further sentences from the same letter may be quoted: 'I was glad at Oxford to see more of Ruskin, who is secretary of our Geological Section. I like him very much.'

the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit. They were Brown, Brewster, Faraday, and Dalton. When we recollect the lovable and serene character of Keble's nature, and that he was at that particular date probably the man in the University who had the greatest power over other men's minds, we can measure the distance we have traversed since that time, and the rapidity with which the converging paths of these two intellectual luminaries, the University and the Association, have approximated to each other. This sally of Mr. Keble's was no passing or accidental caprice. It represented a deep-seated sentiment in this place of learning, which had its origin in historic causes, and which has only died out in our time. One potent cause of it was that both bodies were teachers of science, but did not then in any degree attach the same meaning to that word. Science with the University for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the Middle Ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. Science—science in our academical sense—had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in

those days—that its attractions were at one time potent enough to gather round the University thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendancy even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation. The subject is interesting to us, as this undecided state of feeling coloured the experiences of this Association at its last Oxford visit, nearly a generation later, in 1860. The warmth of the encounters which then took place have left a vivid impression in the minds of those who are old enough to have witnessed them. That much energy was on that occasion converted into heat may, I think, be inferred from the mutual distance which the two bodies have since maintained. Whereas the visit of 1832 was succeeded by another visit in fifteen years, and the visit of 1847 was succeeded by another visit in thirteen years, the year 1860 was followed by a long and dreary interval of separation, which has only now, after four-and-thirty years, been terminated. It has required the lapse of a generation to draw the curtain of oblivion over those animated scenes. It was popularly supposed that deep divergencies upon questions of religion were the motive force of those high controversies. To some extent that impression was correct. But men do not always discern the motives which are really urging them, and I suspect that in many cases religious apprehensions only masked the resentment

of the older learning at the appearance and claims of its younger rival. In any case, there is something worthy of note, and something that conveys encouragement, in the difference of the feeling which prevails now and the feeling that was indicated then. Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in the books of their religion, or, on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man. And the old learning no longer contests the share in education which is claimed by the new, or is blind to the supreme influence which natural knowledge is exercising in moulding the human mind.'

The controversy of 1860, to which Lord Salisbury referred, was concerned with results of Darwin's investigations into the origin of species, and falls for fuller consideration later in this record (Chap. II). But without multiplying examples either of opposition to the Association (which indeed have often been trivial or trivially expressed) or of answers to opponents, it may be added that one of the principal grounds of hostility, shallower, indeed, than those summarised in the quotation above, but nevertheless cogent, is pretty clear. The fundamental idea in the minds of the leading founders of the Association was undoubtedly to create a body which should form a mouthpiece of appeal from science to the world at large, and those who objected did so partly on account of some vague sense that science might degrade itself by making such an appeal, coupled,

perhaps, in individual cases, with a sensation of that mental fatigue which may be induced by digesting scientific problems into a form suitable for the public comprehension, after the philosopher has striven to present them in a form intelligible only to his peers. At no time, however, is there traceable any tendency to allow the meetings to degenerate into popular exhibitions. No less an authority than Murchison (who, as a general officer, fully recognised the value of the popular appeal) took guard against such a tendency when, writing to Whewell on the question of the meeting-place in 1845, he stated that 'we repudiate the idea that the chief aim of our existence is to stir up a few embers of scientific warmth in the provinces. If, indeed, that were truly our main object, I for one would cease to play pantaloon or clown in the strolling company.' It is, however, one matter to capture the attention of the citizens of a single town, but quite another to bring the real interests of science before the public generally, as the Association has done from its earliest years. In 1858, Owen, in his presidential address, was able to express the belief that the Association was 'realising the grand Philosophical Dream or Prefigurative Vision of Francis Bacon, which he has recounted in his *New Atlantis*.' Certainly the 'Father of Modern Science,' in imagining the institution which he called 'Solomon's House,' went near to forecasting much of the activity of the Association, and notably so when he envisaged the sending forth of students of science as 'merchants of light,' to make 'circuits or visits of divers principal cities of the kingdom.'

CHAPTER II

THE ASSOCIATION AND THE PROGRESS OF SCIENCE

The nineteenth century—Physical sciences—Geology and biology: the conflict of science and religion—The formation of the earth—Charles Darwin—The progress of geology—Zoology and botany—Physiology and anthropology—The applications of science.

The Nineteenth Century

Before further discussing the organisation of the Association, it seems essential to essay the difficult task of supplying a framework for the picture: to summarise very briefly the progress of British science during the period of the Association's existence, and not only that, but to offer a view of the national habit of mind (if the phrase be admissible) which made that progress possible. This latter, the broader aspect, may in point of fact be more properly considered first. The foundation of our body was associated, as we have seen, with the vast changes in the national mentality which followed the Napoleonic wars, and blossomed into that brilliant period of (generally) peaceful development which is conveniently known as the Victorian Age.

During the early part of the nineteenth century Britain escaped, as we have seen, from the toils of war; the nation gradually awoke to the necessity of setting its house in order; it acquired method, reconciled in no small measure the warring elements in

opponent classes by widening recognition of some of the better aspects of democracy, searched for improvement in education, social conditions, and mutual understanding. These processes of recuperation may well rest upon some fundamental natural process which is as yet beyond definition; but to them science contributed more than its quota of practical impulse. It provided (for instance) the use of steam, and all that follows from that: this achievement would generally be chosen—if it be fair to choose—as its greatest in this connexion. It befell at the right moment, showing the country how to make use (albeit an extravagant use) of its chief natural wealth, coal.

Fairbairn in his presidential address, 1861, claimed that 'engineering science' had 'pre-eminently advanced the power, the wealth, and the comforts of mankind.' Bramwell (1888) placed this aspect of applied science on an even higher plane: 'Whether it be in the erection of the lighthouse on the lonely rock at sea; whether it be in the crossing of rivers or seas, or arms of seas, by bridges or by tunnels; whether it be the cleansing of our towns from that which is foul; whether it be the supply of pure water to every dwelling, or the distribution of light or of motive power; or whether it be in the production of the mighty ocean steamer, or in the spanning of valleys, the piercing of mountains, and affording the firm, secure road for the express train; or whether it be the encircling of the world with telegraphs—the work of the civil engineer is not of the earth earthy, is not mechanical to the exclusion of science, is not unintellectual; but is of a most beneficent nature, is consistent with true poetic feeling, and is worthy of the highest order of intellect.'

It has not failed to attract such intellect; but we must no longer labour a single point. Before further considering the applications of science, we may compare the pertinent assertion of Silvanus Thompson[1]: 'There never was an age so rich in minds of the first order in science. The nineteenth century has, intellectually, been the golden age, not of art or of poetry, not of drama or of adventure, but of science. It has been an epoch distinguished by a galaxy of men who made it great, and who, whether the world recognises it or not, were great men.'

To trace the progress of science since 1831 through successive meetings of the British Association is impossible in this place. In attempting an outline of that progress, however, it may be premised that the Association has neglected no single step in it. The massive series of the annual reports record it in the pronouncements of presidents and sectional presidents from their chairs, in the reports of research committees, and to some extent, but not, as we shall find, by any means so fully, in the summaries of sectional transactions.

At the time of the foundation of the Association, science was already a powerful body corporate: the period of more or less isolated investigations into individual phenomena, undertaken as dictated by the genius of a few individual thinkers, had already passed away. The interrelation of phenomena was recognised, and the leading cultivators of science were men of wide range of interests—not those of the type identified with a common popular conception of the 'scientist' (as he is popularly termed)

[1] *Life of Lord Kelvin*, p. 1213.

whose life-work is centred upon some minutia of study. The beginnings of evolution are visible, not only in those departments of science with which the word became identified through Charles Darwin, but in all.

Physical Sciences

Thus in the physical sciences we trace this tendency, in the first place, from the isolated work of Newton (1642–1727), who through his demonstration of the force of gravity could apply recognised principles of dynamics to the movement and ordering of the solar system, and enabled later workers, right on into the period of the Association, to discuss its evolution. At the moment of the foundation of the Association astronomy might have appeared almost a complete science, subject only to the collection of additional observations. In this direction, as in other departments of cosmical physics, meteorology, tidal phenomena, etc., the Association rendered powerful service where it was most urgently needed. 'How little has been done for science,' Whewell exclaimed in his presidential address in 1841, 'by the exact and long-continued series of observations, such as he must have before him who is to interpret nature.' Indeed, the collection of observed facts upon which theories might be based and developed, in whatever department of science, has always been a branch of scientific labour for which the Association offers peculiar facilities: it gathers together workers who in course of discussion find subjects in which they require additional data and form themselves into committees for obtaining them. Of this process later chapters will furnish examples.

We then find, in the department of cosmical physics, certain great names primarily identified with the improvement of instruments and methods, and the extension of observation—such names as Sabine (1788–1883), with his labours on terrestrial magnetism and gravity; John Herschel (1792–1871) and Airy (1801–92), with their development of the methods of astronomical observation; the Earl of Rosse (1800–67), with his resolution of some of the nebulae by means of his great telescope; down to that of Gill (1843—1914), with his many activities, especially as H.M. Astronomer at Cape Town, his promulgation of the trigonometrical survey of South Africa, and the establishment of a South African Association on lines similar to our own. Regarding other departments of cosmical physics, we shall see in a later chapter how the Association supported research on tidal phenomena from its earliest days down to the period of the great work of Sir George Darwin (1845—1912): how, also, our body has been identified, peculiarly intimately, with the pioneering work of John Milne (1850–1913) in seismology; and constantly, throughout its history, with progressive researches in meteorology and climatology, which Whewell in the address already cited (1841) considered 'hardly yet a science.'

It is in connexion perhaps with astronomy that the layman's imagination is most strongly moved by the revelations of spectrum analysis. This great branch of study brought the spectroscope to the aid of the astronomers' telescope, and gave them the power to investigate the constitution of certain celestial bodies, as exemplified in the later part of the nineteenth century by the work of Huggins and Lockyer.

Huggins himself, in his presidential address in 1891, recalled that in 1866 he 'had the honour of bringing before this Association, at one of the evening lectures, an account of the first-fruits of the novel and unexpected advances in our knowledge of the celestial bodies which followed rapidly upon Kirchhoff's original work on the solar spectrum and the interpretation of its lines. Since that time,' he continued, 'a great harvest has been gathered in the same field by many reapers. Spectroscopic astronomy has become a distinct acknowledged branch of the science, possessing a large literature of its own and observatories specially devoted to it. The more recent discovery of the gelatine dry plate has given a further great impetus to this modern side of astronomy, and has opened a pathway into the unknown of which even an enthusiast thirty years ago would scarcely have dared to dream.'

In the realm of optics generally, many of the most eminent supporters of the Association were prominent from the first—Brewster, Herschel, and in particular Wheatstone, who described at our meeting in 1835 the spectra of electric sparks passing between the poles of different metals, Stokes (1819–1903), and others, whose work led on to fractions of that executed by three of the greatest figures of the later Victorian and subsequent periods—Crookes, Kelvin, and Rayleigh. The extraordinary versatility of the labours of these three men in science, both pure and applied, are beyond any full discussion here; their names will recur incidentally, but their constant support of the Association (and Kelvin's perhaps above all) demands our most grateful recollection.

At the earlier meetings of the Association, Dalton

(1766–1844), led on from an interest in meteorology and the investigation of atmospheric gases to the enunciation of his atomic theory, was a veteran, an honoured figure. Sedgwick, from the presidential chair of the Association in 1833, referred to him in characteristic phraseology. 'There is a philosopher sitting among us,' he said, 'whose hair is blanched by time, but possessing an intellect still in its healthiest vigour—a man whose whole life has been devoted to the cause of truth—my venerable friend Dr. Dalton. Without any powerful apparatus for making philosophical experiments, with an apparatus, indeed, which many might think almost contemptible, and with very limited external means for employing his great natural powers, he has gone straight forward in his distinguished course, and has obtained for himself in those branches of knowledge which he has cultivated, a name not perhaps equalled by that of any other living philosopher in the world. From the hour he came from his mother's womb the God of nature laid His hand upon him and ordained him for the ministration of high philosophy. But his natural talents, great as they are, and his almost intuitive skill in tracing the relations of material phenomena, would have been of comparatively little value to himself and to society, had there not been superadded to them a beautiful moral simplicity and singleness of heart, which made him go on steadily in the way he saw before him, without turning to the right hand or to the left, and taught him to do homage to no authority before that of truth. Fixing his eye on the most extensive views of science, he has been not only a successful experimenter, but a philosopher of the highest order. His experiments

have never had an insulated character, but have been always made as contributing towards some important end, as among the steps towards some lofty generalisation. And with a most happy prescience of the points to which the rays of scattered observations were converging, he has more than once seen light while to other eyes all was yet in darkness; out of seeming confusion has elicited order; and has thus reached the high distinction of being one of the greatest legislators of chemical science.' Sedgwick proceeded to enjoy, as he expressed it, the 'delightful privilege' of announcing 'that His Majesty, King William the Fourth, wishing to manifest his attachment to science, and his regard for a character like that of Dr. Dalton, has graciously conferred on him, out of the funds of the Civil List, a substantial mark of his royal favour.' It is tempting to speculate upon the views of Brewster, in the light of his opinions upon scientific honours,[1] in regard to this particular form of recognition. Roscoe (presidential address, 1887) recalled that 'the last three of Dalton's experimental essays . . . were communicated to our Chemical Section in 1842, and that this was the last memorable act of his scientific life.'

In the first chapter of their volume *Britain's Heritage of Science*, Sir Arthur Schuster and Sir Arthur Shipley designate ten names as 'landmarks' of physical science, beginning with that of Bacon in the thirteenth century. Of these, five—Dalton, Faraday, Joule, William Thomson (Lord Kelvin), and Clerk Maxwell—fall within the period of the Association. Faraday's great range of discoveries

[1] Chap. I, p. 4.

was brought about 'by the wish to find a common link binding together all the forces which in each branch of physics—gravity, electricity, magnetism, and chemistry—had been treated as peculiar to that branch.' As for Joule's researches into the mechanical equivalent of heat, it is for our purpose sufficient to recall his relations with the Association in connexion with them. He communicated his first ideas as to the mechanical equivalent of the quantity of heat capable of increasing the temperature of a pound of water by 1° F., to the Chemical Section at the Cork meeting in 1843; when they were received with the silence of disapproval. In 1845, at Cambridge, a further paper from him aroused no discussion. A third paper at Oxford, in 1847, might have suffered a like fate, but it was heard by both Faraday and Thomson (Kelvin), the second of whom perceived, as he afterwards wrote, that 'it contained a great truth and a great discovery.' He entered promptly upon a discussion of the matter—whether openly in the section is not clear, but certainly with Joule personally—and from that occasion there date at once the gradually extending acceptance of Joule's results and an intimate relationship between his labours and one department of Kelvin's many activities. Kelvin's demonstration of the 'universal tendency to the dissipation of mechanical energy' supplemented Joule's results. Clerk Maxwell (1831–79) supplemented Faraday's experiments in electricity by mathematical demonstration.

Joule was prevented by ill-health from being president of the Association at the Bradford meeting in 1873. Sir Oliver Lodge, recalling this as the first meeting attended by him, writes thus of it:

'The meeting was memorable for the galaxy of mathematicians which assembled under the presidency of Professor Henry J. S. Smith. In the small meeting-room were gathered together Clerk Maxwell, Cayley, Sylvester, W. K. Clifford, Spottiswoode, and J. W. L. Glaisher, the last being chief Secretary of the Section; also Robert S. Ball, then speaking on his theory of screws, Osborne Reynolds, Balfour Stewart, J. D. Everett, Arthur Schuster, Alexander Herschel, and George Forbes: M. Janssen was also present, William Huggins, and Lord Rayleigh. Several other pure mathematicians were present, including the Rev. Robert Harley. The result of the meeting was to awaken a keen enthusiasm for the intricacies of pure mathematics. One of the evening lectures was that memorable discourse by Clerk Maxwell on molecules, now accessible in his reprinted papers, given in a manner which riveted the attention of the audience. It was a serious contribution to molecular physics at that period, and incidentally it serves to show how absolutely remote was the notion of atomic constitution and variability.' In this connexion reference is due to a much earlier noteworthy event in the annals of the Association. At the Sheffield meeting in 1879, Crookes delivered a discourse on radiant matter, in the course of which he demonstrated for the first time many of the mechanical thermal and phosphorescent properties of the stream of electrons in a vacuum tube, now known as cathode rays. On this foundation the science of radio-activity was subsequently built.

In the volume by Schuster and Shipley already cited, it is shown how, as far as concerns physical science, 'in the seventies of last century, it was

generally thought that our power to discover new experimental facts was practically exhausted.' The Earl of Rosse, in his presidential address in 1843, at once foreshadowed this attitude of mind and offered an explanation and a corrective: 'Each successive discovery, as it brings us nearer to first principles, opens out to our view a new and more splendid prospect, and the mind, led away by its charms, is carried beyond and far above the petty and ephemeral contests of life; but the more rapid the discoveries are, the more powerful the charm, and therefore great is the motive for exertion; and in labouring in this cause there is this gratifying reflection, that our labours cannot injure our successors, for the region of discovery is rich beyond the powers of conception.' A new era in physical research opened when Rayleigh, observing two different densities for nitrogen obtained by two different methods, was led, in conjunction with Sir William Ramsay, to the discovery of a new gas in the atmosphere, which was announced at the meeting of the British Association in 1894, and was named argon. Ramsay (1852–1916) proceeded to the brilliant researches by which he isolated further new elements. Again, experiments on the discharge of electricity through gases, carried on by Crookes and others, led up to the conception of the atomic constitution of electricity, and Sir J. J. Thomson demonstrated the existence of the electron, of smaller mass than the chemical atom, as the carrier of negative electricity. This discovery, again, was proclaimed at a British Association meeting at Dover in 1899.

The occasion of this announcement by Thomson 'On the Existence of Masses smaller than the Atoms'

was enhanced in interest by the presence of members of L'Association Française pour l'Avancement des Sciences, who attended the meeting of the British Association from their own meeting-place at Boulogne across the Channel. Thomson's paper was followed in the programme by one on the controversy concerning the seat of Volta's contact force from Sir Oliver Lodge, who has told the compiler of this record how he could not refrain from continuing to discuss the preceding 'epoch-making communication,' so that his own subject received scant attention. Again, at the Leicester meeting in 1907, there took place what Silvanus Thompson [1] has described as 'one of the most instructive discussions ever known in the Association,' on the constitution of the atom, opened by Professor [Sir] Ernest Rutherford. In this there took part Sir Oliver Lodge, Sir William Ramsay, Professor Frederick Soddy, Sir Joseph Larmor, and finally Kelvin, whose last public appearance this meeting proved to be; he died at the end of the same year. Kelvin's activities at Leicester, in his eighty-fourth year, brought fittingly to a close his unremitting attachment to the interests of the Association. He had proposed the vote of thanks to Gill for his presidential address; he had read a paper on the motions of ether produced by collision of atoms or molecules containing or not containing electrons; and now he keenly entered into debate, holding as he did that the atom was an indivisible unit, and that therefore it could not, as such, be said to possess a constitution.

Lastly, the discovery of X-radiation, apart from its now familiar and infinitely valuable benefits to

[1] *Life of Lord Kelvin*, p. 1201.

surgery, pointed on investigation to another and distinct form of radiation, the knowledge of which proved a preliminary to the discovery of radium and other radio-active substances, and to the theory of radio-activity with which are associated the names of Sir Ernest Rutherford and Professor F. Soddy. To the study of this subject the Association has applied the gift which, as recorded elsewhere (p. 151), was made to it for the purpose by Sir James Caird in 1913.

Geology and Biology: the Conflict of Science and Religion

When the Association was founded James Hutton was thirty-four years dead, and his pupil, John Playfair, had in 1802 published his work on the 'Huttonian theory' which formed the basis for all subsequent work upon the shaping and evolution of the face of the earth as we now see it, and led investigators to look back through the æons of geological time. Lyell first issued his standard work on *The Principles of Geology* two years after the first meeting of the Association. The new conception of the slow process of earth-building (apart from its purely scientific discussion, to which we must refer later) conflicted with the views of those who would literally interpret the scriptural description of the Creation, and would assign to the process a period of 'days.'

From this and the subsequent enunciation of the evolutionary theory as applied to life on the earth, it results that of the meetings of the Association or its sections which may conveniently be labelled as 'famous occasions,' several are connected with the

supposed opposition between teachers of science and of Christianity. The conflict between science and religion is as old as the younger of the combatants, and this is not the place to attempt even a summary account of it. It must suffice to observe that the battle-ground has shifted periodically, the fight blazing up around a succession of scientific facts as each in turn was demonstrated: in the intervals, there have been periods of quiescence.

We shall illustrate in the following chapter the powerful influence of the clergy in science at the period of the foundation of the Association. The names of Whewell, Sedgwick, Buckland, and Harcourt are accompanied by many others of clergymen only less eminent in science, in the early annals of our body. And among the lay philosophers of the time there were then (and, for that matter, have always been) many who in their own minds felt no opposition between science and religious faith. We need go no farther for proof than our own presidential addresses, with their often-recurring perorations upon the aim of science toward an understanding of the wisdom of the Creator. Johnston, upon whose account of the first meeting of the Association we have previously drawn, writes thus in regard to the clergy's part in it:

'Among the friends and patrons of the society at York who paid kind and hospitable attention to those whom the love of science had brought to the meeting, the clergy must not be passed over in silence. They had been the zealous promoters of the meeting; had done much towards facilitating the preliminary arrangements; and exerted themselves by their influence and example to secure to the

Association that respect and general attention which it deserved, and which at York it amply received. To the Church, therefore, the British Association is deeply indebted; and convinced as I am that true religion and true science ever lead to the same great end, manifesting and exalting the glory and goodness of the great object of our common worship, I trust that the firmer the Association is established, and the more influential it becomes, the more willing and the more efficient an ally it will prove in the cause of religion.'

It is scarcely possible to assert that that hope has been fulfilled, at least directly; and the first dispute of the nature under consideration in which the Association became involved was not merely between science and religion, but one which divided the clergy themselves. On the one hand, we find a divine of some distinction endeavouring (on the most charitable view) to adapt scientific reasoning to his own conception of Christian teaching; on the other, eminent cultivators of science, of his own cloth, are his principal opponents.

The Formation of the Earth

The Very Rev. William Cockburn, D.D., Dean of York, might have been a true descendant of Cosmas Indicopleustes. Cockburn was obsessed with the belief that the statements of Holy Scripture in regard to the creation of the earth were being controverted by the doctrines of geology, particularly as enunciated by Buckland in the famous *Bridgewater Treatise*. In 1838 he had published 'A Letter to Professor Buckland, concerning the Origin of the World,' and

'A Remonstrance upon the Dangers of Peripatetic Philosophy'—a pleasantly ornate alias for the British Association—addressed to the Duke of Northumberland, its president in that year. At the second York meeting, in 1844, he was on his own ground: the Geological Section, in any case, could scarcely have refused his offered paper, 'Critical Remarks on certain Passages in Dr. Buckland's Bridgewater Treatise,' for, incredible as it may now appear, the Dean had his own pretty extensive following. His paper, which crowded the section, opened with an endeavour to demolish Buckland's theories as to the formation of the earth, and then proceeded to develop his own, which in summary were these: 'I suppose that everything in the world was made at one time; nothing has been added, nothing taken away. The world was as now, land and water, both resting on a strong basis consisting of the granite rocks. So the world continued for nearly 2000 years—the land, the air, and water being all thickly peopled. There then burst forth, by natural or supernatural means, numerous submarine volcanoes. The first broke through the crust of granitic stones, and threw up, but not to the top of the water, a great quantity of these pulverised and perhaps melted stones mixed with clay, which, slowly subsiding in the tranquil sea, produced the strata of the transition series.' The Flood was invoked as a further supernatural agent, and 'the embedded fossils represent the remains of animals that were alive when the convulsions began, and were so obliging as to die in the definite and regular order in which their shells and bones are now deposited.'[1]

[1] *Life and Letters of Sedgwick*, ii, 76. This last, it need hardly be added, is not a quotation from the paper.

Adam Sedgwick, doctor of divinity equally with Cockburn, and man of science incomparably above him, was put up to oppose the Dean, and did so to the alternate amusement and exaltation of his audience. His castigation, however, did not silence the Dean for the future, and the paper, published under the title of 'The Bible defended against the British Association,' ran through five editions in a year. This in itself is sufficient evidence that the whole incident was less trivial than it now appears; but even without such evidence it would have been worthy of a reference. For it demonstrates that science, through the British Association and other media, has, in much less than a century, so far penetrated the minds of men that the folly of Dean Cockburn would now be regarded as abysmal by almost any person of any pretence to education. But something of the Dean's outlook survived for many years, for Tyndall's wrath was stirred (presidential address, 1874) against those 'dignitaries who even now speak of the earth's rocky crust as so much building material prepared for man at the Creation. Surely,' he added, 'it is time that this loose language should cease.'

It is unhappily noticeable that since the first meeting, when in the list of scientific sub-committees (p. 79) twelve places out of forty-one are filled by clergymen, there has been a marked decrease in the proportion of eminent clerical cultivators of science; subject, it need hardly be added, to certain brilliant exceptions down to the present time. It may well be that the clergy came increasingly to lack encouragement in this direction: on this view, it is of interest to quote the Parliamentary Committee of the Asso-

ciation (*cf.* p. 219) in a report of 1855 on possible Government measures to improve the position of science. 'Promotions in the Church,' the Committee remark, 'have been occasionally made avowedly on the ground of literary merit; but if such claims be admissible, it would seem that scientific acquirements should not be overlooked in an age in which scepticism has been nourished by mistaken views of physical phenomena.'

Charles Darwin

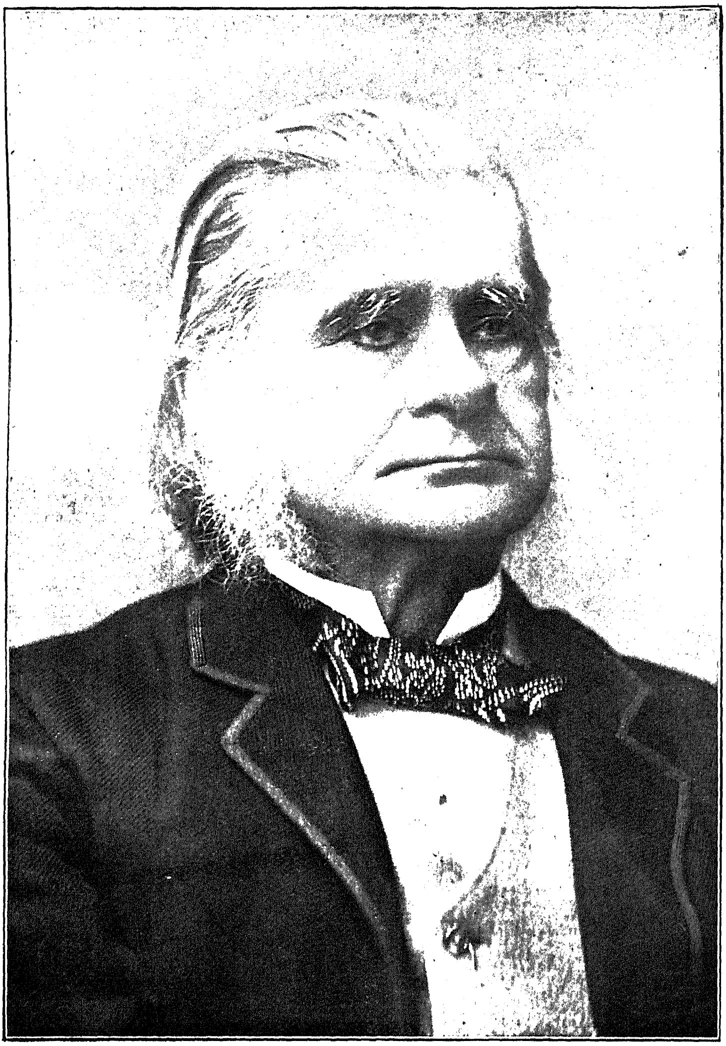
But the second of the two battles between science and orthodoxy which were fought in part at Association meetings, helped largely to send clergymen and men of science off on different tracks in the pursuit of knowledge. In 1859 appeared Charles Darwin's *Origin of Species*, and it is unnecessary here to give details of the outburst of enthusiasm on the one hand and execration on the other, with which it was received. Darwin's own health had by this time precluded him from entering any public arena in support of his opinions, but among his devoted champions many, and notably Hooker and Huxley, were more or less regular attendants at the meetings of the British Association. So were, or had been, many of his opponents—Sedgwick, for example, and Whewell, and Owen, and one most intimately connected with our body—John Phillips. The book, in fact, divided science against itself; but that was a division which might be expected to be gradually closed in the course of calm discussion and consideration: more vociferous was the popular criticism, supported by religious opinion, which centred upon the theory which presented itself to the popular mind

as 'the descent of man from the ape.' Not all the previous dissensions between scientific and religious thought had prepared men's minds for so flat a contradiction of the circumstantial scriptural statement concerning the creation of man. Here, moreover, was a subject that was capable of scientific discussion, at least on general lines, in terms intelligible to the general public; unlike some which have caught the public fancy, perhaps, by reason of their very unintelligibility save to the trained intellect. And the British Association, known in journalistic term as the 'parliament of science,' was the obvious body under the auspices of which the safety-valve of speech (as distinct from that of the pen) might be released. Yet it is in a measure characteristic of our body that the discussions of the Darwinian theory in the Section of Botany and Zoology, which made the Oxford meeting in 1860 the most widely famous ever held, were not, apparently, organised as occasions for the public ventilation of the whole matter: the celebrated debate between Owen and Huxley during this meeting, and subsequently that between Samuel Wilberforce, Bishop of Oxford, Huxley, Hooker and others, followed almost fortuitously upon the reading of papers not, in themselves, of special distinction. It is also, incidentally, an unhappy commentary on the limitations of the Association in reporting its own transactions—limitations for which no remedy has ever been found—that no reference whatever to these two pre-eminent episodes appears in the annual report for 1860, beyond the jejune abstracts of the two papers (by Dr. C. G. B. Daubeny and Professor Draper of New York respectively) which opened the way for the protagonists.

Darwin's most powerful supporters, Hooker and Huxley, were definitely averse from this form of discussion. After Daubeny's paper, Huxley pleaded that 'a general audience, in which sentiment would unduly interfere with intellect, was not the public before which such a discussion should be carried on.' But when Owen asserted that the differences between the brains of the gorilla and man were greater than those between the gorilla and 'the very lowest of the Quadrumana,' Huxley was forced to meet him with a direct contradiction, which he subsequently justified by evidence. Two days later the battle was rejoined more ardently. Wilberforce, Bishop of Oxford, was announced to speak in the section, which was thereupon crowded to such degree that its meeting-room must be changed for the occasion. Hooker and Huxley would fain have absented themselves: only personal appeals brought them to the meeting. The speeches were not fully reported at the time, but the incidents of the meeting are preserved in correspondence and from personal recollections, and are detailed in the Lives of Darwin, Huxley, Hooker, and Lyell, and elsewhere. After Draper's paper, none of the minor combatants was allowed by the audience to delay the access of the bishop to the platform, and he was the first to secure a protracted hearing. To his scientific listeners, he betrayed his ignorance in almost every sentence, as he had previously in a review of Darwin's book in the *Quarterly Review*; it was also patent to them that Owen had coached him. But in his peroration he made an almost incredible false step, when he refused, for himself, to regard monkeys as his ancestors, and turned to Huxley to ask whether it was through his

grandfather or his grandmother that he claimed descent from a 'venerable ape.' Huxley took the opportunity offered. Of the various versions of his retort it is perhaps most appropriate for us to quote that recalled by a late General Secretary of the Association, Dr. A. G. Vernon Harcourt, and furnished to the biographer of Hooker and Huxley: 'If I am asked whether I would choose to be descended from the poor animal of low intelligence and stooping gait, who grins and chatters as we pass, or from a man, endowed with great ability and a splendid position, who should use these gifts to discredit and crush humble seekers after truth, I hesitate what answer to make.' Hooker followed up this castigation of the bishop, and as he wrote to Darwin, 'hit him in the wind at the first shot in ten words taken from his own ugly mouth.' We are free to conjecture as to the validity of the narrative in the biography of the bishop himself,[1] which thus records the episode: 'The bishop . . . made a long and eloquent speech condemning Mr. Darwin's theory as unphilosophical and as founded on fancy. . . . In the course of this speech, which made a great impression, the bishop said that whatever certain people might believe, he would not look at the monkeys in the Zoological Gardens as connected with his ancestors, a remark that drew from a certain learned professor the retort, "I would rather be descended from an ape than a bishop."' It is difficult to feel that this latter version, as an historical record, is any more justifiable than the bishop's own lapse from the amenities of debate.

[1] *Life of the Rt. Rev. Samuel Wilberforce, D.D.*, by R. G. Wilberforce (1881).



HUXLEY

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TYNDALL.

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There would appear now, after the lapse of more than half a century, no doubt that Darwin, through his supporters, was left master of the field. But in reality, on this occasion, the battle was no better than drawn. Two years later, at the meeting in Cambridge (1862), the issue was rejoined, and although Owen was again discounting the theory of natural selection in connexion with a study of the characters of the aye-aye, the consolidation of Darwin's triumph was much more clearly foreshadowed. The Rev. W. N. Molesworth stood up to support the necessity for theories such as Darwin's (without committing himself to supporting Darwin's own), in order to 'let us push our investigation of the Creator's works in every direction, without the slightest fear that scientific truth can ever clash with moral and religious truths.' Clerical attacks continued, nevertheless, for some years, but gradually died down; and it may fairly be hoped that any such feeling as was generated at that period upon religious grounds need never recur. The common aims of science and religion, to which the elucidation of individual details must always, in reality, be subordinate as parts to the whole, were set forth by Canon E. W. Barnes, F.R.S.,[1] in 1920 on the occasion of the Association's meeting at Cardiff, in a sermon which clearly impressed those who were privileged to listen to it far more than those who read the published summaries.

The Progress of Geology

Reverting to the subject of geology, we find that its very name is little more than half a century older

[1] Of Westminster.

than the Association. We may date the modern development of stratigraphical study in Britain from the work of William Smith (1769–1839). The rocks, older than the Coal Measures, which were left untouched by him, were investigated by two of our own most eminent figures of the earlier years: Sedgwick in North Wales and Murchison in South Wales. Later, the classification in detail of strata according to their points progressed rapidly through the efforts of many observers, while in 1840 Agassiz, visiting Britain, adduced a new conception of the origin of much of the surface covering of our islands—through glacial agency, though his opinions did not for some time obtain general adoption. Meanwhile, the knowledge of the physiographical side of geology remained in a rudimentary condition: the general tendency was to assign the origin of existing land-forms to some convulsive operation of nature, and such movements or processes as submergence and elevation, erosion and denudation, were very imperfectly understood, if at all. Controversy arose between 'catastrophist' and 'uniformitarian' schools of thought. The first sought evidence that the operations of nature were in earlier periods of the history of the earth's formation more powerful and spasmodic than at the present time, and that in these processes early races of plants and animals were wholly destroyed, to be replaced by new ones. The uniformitarians, basing their ideas upon extended applications of Hutton's views, admitted no evidence of alteration in geological causes. Lyell, leader of this school, in the maturity of his presidential address to the Association in 1864, adverted to 'two points on which a gradual change of opinion has been taking

place among geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough to remember,' he continued, 'when geologists dogmatised on both these questions in a manner very different from that in which they would now venture to indulge.' A sidelight upon the controversy of interest to us appears in connexion with the fact that uniformitarian views were contested by Thomson (Kelvin) on the ground that they entailed altogether exaggerated ideas of the extent of geological time. He thus found himself in opposition with Darwin and Huxley among others; but Huxley, in introducing him as his successor to the chair in 1871, was able to quote the phrase:

> Gentler knight
> There never broke a lance.

Kelvin, in the address so introduced, referred to the hypothesis of 'the origin of species by natural selection,' upon which he commented thus: 'I have always felt that this hypothesis does not contain the true theory of evolution, if evolution there has been, in biology.' Twenty-three years later the Marquis of Salisbury, in his presidential address at Oxford, quoted Kelvin's view of the duration of geological time as one of the strongest objections to the Darwinian explanation of 'the origin of the infinite variety of life.' It was a noteworthy circumstance that Kelvin himself and Huxley should respectively propose and second the vote of thanks for this

address ; Huxley, at this his last public appearance, worthily played his part of champion to the end. Two years earlier (Edinburgh, 1892) Kelvin, in commenting upon Sir Archibald Geikie's presidential address, had been able to refer with satisfaction to developments 'according to which geologists find it possible to hurry up the action without abandoning any fundamental principle of the Huttonian theory.' This is not the place to pursue the geological controversy further, but it should be observed that physicists now offer the supporters of evolution the view that the age of the earth must be increased by many millions of years above the figures for which Kelvin argued. In a discussion on this subject at the Edinburgh meeting in 1921, Lord Rayleigh showed that Kelvin's calculations are upset by the discovery of radio-active substances in the earth, since studies of the duration of time needed for known changes of these substances to take place have resulted in assigning 'a moderate multiple of 1000 million years as the possible and probable duration of the earth's crust as suitable for the habitation of living beings.'

Lastly, the subject of petrology, concerned with the minute examination of the composition of rocks, may be said to have been established by Henry Sorby's paper 'on a new method of determining the temperature and pressure at which various rocks and minerals were formed,' read at the Leeds meeting of the Association in 1858.

Zoology and Botany

There might be a superficial temptation to date the progress of zoology and botany during our period

from Darwin's time, when we find that down to 1867 botany was represented in the chair of the Association only by the versatile Daubeny (1856), and zoology only by Owen (1858). Daubeny was no less eminent as chemist and geologist than as botanist: in fact he carried on his shoulders more than his share of the burden of natural science in the unscientific Oxford of his day. But the chair of the Association missed the honour of having as an occupant Robert Brown (1773–1858), by general consent one of the greatest of British botanists, in whose work is found the basis of much fine work of later years in the classification of plants which replaced the Linnaean system. Owen was a man capable of lifting his science higher into general notice than the botanists of his time did theirs: he was a man of affairs, able to take advantage, for instance, of the new interest in science at Court engendered by the Prince Consort (who, it may be observed, followed him immediately in the presidency of the Association). His services to the observational side of zoology were in some measure obscured by his opposition to Darwin, and were at least equalled by his powers of organisation: during his period as superintendent of the Department of Natural History in the British Museum the building in South Kensington was opened (1881).

On Darwin's revolutionary influence upon public interest in science it is needless to insist further: his demonstration of the grand common interests of science itself is typified, in a measure, by the diversity of the labours of three great men who were united in the championship of his cause, themselves leaders in three different branches of science—Lyell in geology, Hooker in botany, Huxley in zoology: Hooker the

particularise more closely) in the study of the distribution of plants; Huxley in that of morphology.

The whole period, down to Darwin's time and after, was one in which many great zoologists and botanists were also great travellers: Brown, Darwin himself, and Hooker studied their subjects in many lands, and among other names that of A. R. Wallace stands out. And the same is true of students in a special field peculiarly appropriate to Britain and supported from its early years by the British Association —that of marine biology. From 1840 onward, with the support of the Association, Edward Forbes was at work in the Aegean Sea and elsewhere; and the Association had a share in promulgating the culminating expedition for the study of the sea which was carried out on board H.M.S. *Challenger* in 1872–76.[1] A recent movement in favour of another such expedition, originated in the Association (1920), is no more than delayed, it may be hoped, by the unfavourable condition of national finance. Indeed the work of the travelling biologist, whether at sea or on land, is far from finished yet, and even the brief visits of the Association overseas have afforded notable opportunities in this direction.

The question of variations in nature tending toward the so-called survival of the fittest was of course studied before Darwin's day, and modifications of his views have been introduced since. Sudden and marked variation, for example, has been recognised rather as a normal than as an extraordinary process, when such variation proves itself better capable of survival than the parental type. With

[1] See, further, pp. 196, 228.

the study of variation is associated that of inheritance, based upon the work of Mendel, which, appearing in 1865, was unknown to Darwin, and remained unrecognised until the beginning of this century. Professor W. Bateson (presidential address, 1914) thus summarised the view which has come to be widely held of Darwin's labours:

'We have come to the conviction that the principle of Natural Selection cannot have been the chief factor in delimiting the species of animals and plants, such as we now with fuller knowledge see them actually to be. We are even more sceptical as to the validity of that appeal to changes in the conditions of life as direct causes of modification, upon which latterly at all events Darwin laid much emphasis. But that he was the first to provide a body of fact demonstrating the variability of living things, whatever be its causation, can never be questioned.'

Physiology and Anthropology

A marked change is seen in the position of physiology as between the first half of the nineteenth century and the second. In the earlier time the teaching of physiology was largely ancillary to medical practice, although the case of W. Sharpey, after the first few years of his working life, provides a notable exception. Physiology was also closely associated with zoology on its morphological and anatomical side, and so remains; but it came to stand more firmly on its own independent basis, through the efforts of such men as Sharpey's famous pupils, Michael Foster and Burdon-Sanderson, and the brilliant band of students who sat under them

respectively at Cambridge, and at London and Oxford. On the far-reaching effects of physiological research upon medicine and surgery—as illustrated by the work of Sir James Simpson, Edward Jenner, and Lord Lister—it is unnecessary to enlarge. But the evolution of the science generally was very clearly pointed out by Burdon-Sanderson in his presidential address in 1893, from which, mainly in his own words, the following account is summarised. Just as there was no true philosophy of living nature until Darwin (he said), we may with almost equal truth say that physiology did not exist as a science before Johannes Müller, who taught in Berlin from 1833 to 1857. Müller himself, in common with all the biological teachers of his time, was a vitalist, *i.e.*, he regarded what was then called the *vis vitalis* as something capable of being correlated with the physical forces, and as a necessary consequence held that phenomena should be classified or distinguished, according to the forces which produced them, as vital or physical, and that all these processes—that is groups or series of phenomena in living organisms—for which no obvious physical explanation could be found, were sufficiently explained when they were stated to be dependent on so-called vital laws. But times were changing, and Müller's successors were adherents of what has been very inadequately designated the mechanistic view of the phenomena of life. The change thus brought about just before the middle of the century was a revolution. It was not a substitution of one point of view for another, but simply a frank abandonment of theory for fact, of speculation for experiment. Great discoveries as to the structure of plants and animals had been

made, resulting especially from the introduction of the microscope as an instrument of research. The structural conditions on which the processes of life depend had become accessible to investigation. The application of experimental methods derived from the exact sciences aroused hopes for the solution of many physiological problems. Progress in the science of chemistry afforded ground for such hopes, and particularly the discovery that many of the compounds which before had been regarded as special products of vital processes could be produced in the laboratory. In like manner the new school of physiology profited by the advances which had been made in physics, partly by borrowing from the physical laboratory various improved methods of observing the phenomena of living beings, but chiefly in consequence of the direct bearing of the crowning discovery of that epoch, that of the conservation of energy, and the discussions which then took place as to the relations between vital and physical forces.

A section of Sir Edwin Ray Lankester's presidential address in 1906 is headed with the word 'Psychology,' and he observed:

'I have given a special heading to this subject because its emergence as a definite line of experimental research seems to me one of the most important features in the progress of science in the past quarter of a century. . . . The physiological methods of measurement (which are the physical ones) have been more and more widely, and with guiding intelligence and ingenuity, applied since those days to the study of the activities of the complex organs of the nervous system which are concerned with

"mind" or psychic phenomena. Whilst some enthusiasts have been eagerly collecting ghost stories and records of human illusion and fancy, the serious experimental investigation of the human mind, and its forerunner the animal mind, has been quietly but steadily proceeding in truly scientific channels. The science is still in an early phase—that of the collection of accurate observations and measurements—awaiting the development of great guiding hypotheses and theories. But much has been done: . . .'

and it was not long after these words were spoken that the subject of psychology demanded for its exposition a subsection under the Section of Physiology in the Association, from which it advanced to the dignity of a section in 1921.

It has been the business of our anthropological section to keep track of an extensive range of subject-matter. On the one hand we have the world-wide studies of native peoples in their physical and social aspects, carried on by many travellers; on the other, the interests of archæology, with all the investigations carried on at home, in the Mediterranean area, and in other fields during our period, are committed to the charge of this same section. Again, the section has to deal with the science of anthropometry and allied investigations, such as were initiated by Francis Galton (1822–1911), who, following the doctrines of his cousin Charles Darwin, introduced methods of accurate measurement and the use of statistics into the study of heredity, and originated that conception of the improvement of the human race by careful breeding to which he gave the name of eugenics.

The Applications of Science

For monuments of applied science it is necessary only to look around : we need attempt no catalogue. We may begin to realise its prolific and marvellously rapid development from such recollections as these : that Henry Bessemer first publicly described at the meeting of the Association in 1856 his researches which were to revolutionise the steel industry ; that the commercial applications of electricity are broad-based upon the work of Faraday, coupled with the invention of the electro-magnet by Sturgeon (1783–1850) ; that all the vast development of these applications, at the hands of Wheatstone, Kelvin, John Hopkinson (1849–98), Ayrton (1847–1908), and many another, dates from a time substantially later than the foundation of our body. This development continues to the present day, when, for example, the uses of telephony and telegraphy have extended far beyond the conception of most of those who witnessed early demonstrations of these wonders at meetings of the Association. At the Plymouth meeting in 1877 W. H. Preece demonstrated various types of telephone. Criticism of the telephone service in recent years has made play with the assertion that Preece, being then an official of the Post Office, called the telephone 'a pretty philosophical toy,' which is not true : he did apply that stricture to an early instrument by Philip Reiss (1861), which could convey only tone and not speech ; but he recognised the potentialities of Graham Bell's system.[1] So did Thomson (Kelvin) and Haughton, who amused

[1] Dr. Alexander Graham Bell had patented his telephone in 1876.

themselves and the company by speaking through the demonstration instrument in dialect.

At the meeting in 1888, at Bath, Fitzgerald, as president of Section A, made the announcement of Hertz's verification of Clerk Maxwell's theory of electro-magnetic waves. A discussion on lightning conductors also took place, in which the importance of self-induction in connexion with sudden discharges was for the first time emphasised, and the production of waves of measured length on conducting wires was first made public by Sir Oliver Lodge. At the Oxford meeting in 1894 Sir Oliver Lodge gave the first public demonstration of 'wireless,' over a distance of a few hundred yards, effecting the reception of Morse signals by the long and short deflections of a Thomson marine-signalling galvanometer, such as had been used in cable telegraphy. Thus was revealed the possibility of signalling by means of Clerk Maxwell's and Hertz's electro-magnetic waves, although the name of wireless telegraphy was introduced only in 1896 by Marconi, when its practice was begun in the face of many difficulties, initially with the help of the Post Office authorities in this country. In 1907 at Leicester, Duddell, in giving an evening discourse on the arc and the spark in radio-telegraphy, showed experiments which formed the foundation for continuous wave telegraphy.

With such advances as these, as with those in other departments of engineering—for instance, the steam turbine, the internal combustion engine, the aeroplane—our engineering section has been principally concerned. Thus, at the York meeting in 1881, J. Emerson Dowson showed his plant for producing gas for motive power in the factory, etc., and

the first demonstration was given of its use in driving an Otto gas-engine. At the Oxford meeting in 1894 there was a discussion on Maxim's flying machine, and Kelvin, who had no belief in the aeroplane, described this example afterwards as 'a kind of child's perambulator with a sunshade magnified eight times.' Mention of Maxim recalls a vision of himself, exhibiting the gun named after him, mounted upon cycle-wheels, at the Ipswich meeting in 1895. In other directions of the commercial application of science the section of chemistry is perhaps chiefly interested. Progress during our period includes that in the coal-tar and alkali industries, the improvement of explosives, and many other directions: in some, the Great War was needed to enforce upon men's minds the powers of science.

Our endeavour in preceding paragraphs has been to set up a few guide-posts to the advance of science, which will be supplemented by many further examples, where the Association has been directly concerned, later on; especially in those chapters which deal with researches to which our body has given its support. From time to time presidents of the Association have furnished summaries of progress in science generally or in one or more of its component departments; but, as Sir Ray Lankester observed in one such survey,[1] 'the mere enumeration of the most important lines of progress in any one science would occupy us for hours.' It has been attempted also to show in this chapter that the progress of science is evolutionary, although any one incident in that progress may be revolutionary. Into the

[1] At York, 1906. For others, see especially Lubbock, 1881; Douglas Galton, 1895.

story of the advancement of science there is further to be read the essential homogeneity of science as a whole, and the constant interaction and interdependence of its several departments.

A negation of this condition might be inferred from the successive creation of sections in the Association, which we have next to consider. Actually, there is no such negation, whatever tendency may have supervened, during the later part of our period, toward specialisation by individual scientific workers in particular directions of study. The formation of our sections may be viewed from two different angles, to each of which an aspect of homogeneity, after all, is common. In the first place, those who practice in a pure science, or a group of pure sciences, come together to form such sections as those of mathematics and physics, chemistry, geology, or the biological sections. Secondly, we have the common interests of those who teach, whatever science they teach; of those who travel or study geography, with whatever sister science (if any) they are also concerned; of those who are interested in economic and statistical applications; of those who apply science, of whatever department, to agriculture: and so forth. Thus it comes about that we encounter demands for sections of education, of geography, of economics, of agriculture. The constitution of the Association, being elastic, can adapt itself to such demands of science as it progresses: it is unique among the major scientific bodies in the United Kingdom as possessing that elasticity, and admitting the widest possible range of scientific interest. But, as we shall see, it also endeavours to bring kindred departments of science together on common ground.

CHAPTER III

ORGANISATION

The Sections—Conviviality: the 'Red Lions'—Public interests at the meetings—Corresponding societies—Membership of the Association—Public lectures—The Presidency of the Association—Royal interest.

The Sections

The nucleus of the present sections of the Association, in which the bulk of the scientific work at annual meetings is transacted, was evolved in 1835 after a period of experiment during which more than one grouping of the sciences were attempted. In 1831 'sub-committees,' under the General Committee, not distinguished by any letter or number, were formed as follows. The names of their members are worthy of record: incidentally they give point to the order in which Brewster places the component social and intellectual groups of the Association—'our nobility, clergy, gentry, and philosophers.' The intimacy between scientific and ecclesiastical interests at that time, to which we have already referred, is revealed in the list which follows.

Sub-Committees

Mathematical and Physical Science

David Brewster, LL.D., F.R.S.
Sir Thomas Brisbane, K.C.B., F.R.S.
J. D. Forbes.
W. R. Hamilton, F.R.S.
Rev. W. Pearson, LL.D., F.R.S.
Rev. Baden Powell, F.R.S.
Rev. W. Scoresby, F.R.S.
Rev. W. Whewell, F.R.S.
Rev. R. Willis, F.R.S.

Chemistry

Rev. J. Cumming, F.R.S.
J. Dalton, F.R.S.
Dr. C. Daubeny, F.R.S.
Rev. W. Vernon Harcourt, F.R.S.
J. F. W. Johnston
Dr. E. Turner, F.R.S.
W. West

Mineralogy

J. Allan, F.R.S.
R. Allan
David Brewster, LL.D., F.R.S.
J. F. W. Johnston
Rev. W. Whewell, F.R.S.

Geology and Geography

Rev. W. Buckland, D.D., F.R.S.
Rev. W. Conybeare, F.R.S.
Sir P. Grey Egerton, Bart., F.R.S.
J. D. Forbes
G. B. Greenough, F.R.S.
William Hutton
R. I. Murchison, F.R.S.
John Phillips
Rev. Adam Sedgwick, F.R.S.
William Smith
H. Witham
James Yates

Zoology and Botany

Dr. C. Daubeny, F.R.S.
Dr. J. K. Greville.
Rev. Professor J. S. Henslow
Professor J. Lindley, F.R.S.
Dr. J. C. Pritchard, F.R.S.

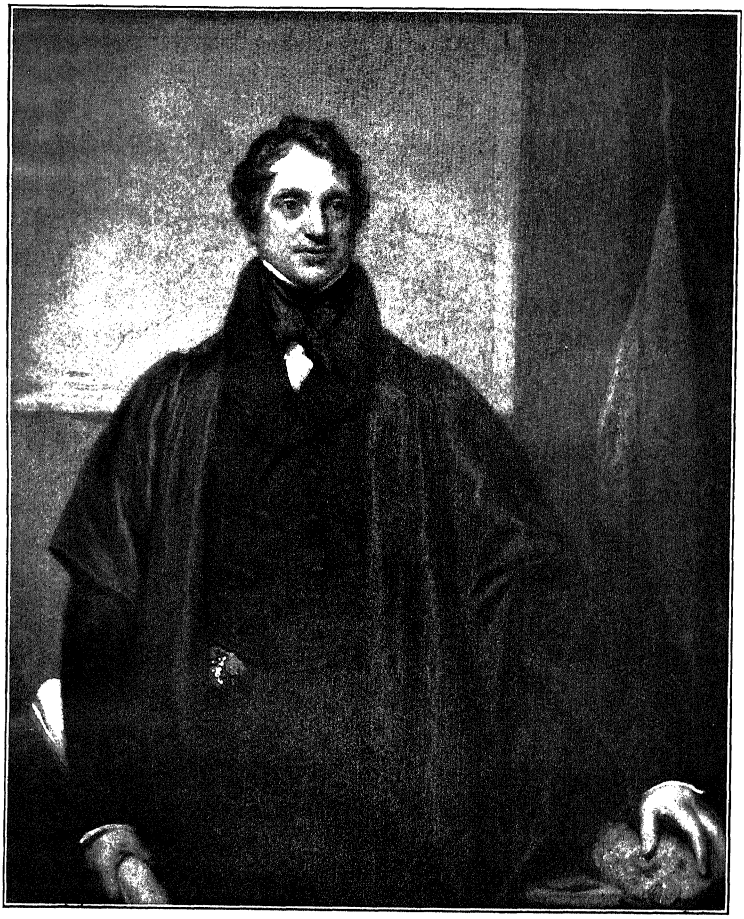
Mechanical Arts

J. H. Abraham
John Robison
Benjamin Rotch

In 1832 these bodies take on the dignity of committees, and are entitled thus :

I. Pure Mathematics, Mechanics, Hydrostatics, Hydraulics, Plane and Physical Astronomy, Meteorology, [Terrestrial] Magnetism, Philosophy of Heat, Light, and Sound.
II. Chemistry, Mineralogy, Electricity, Magnetism.
III. Geology and Geography.
IV. Zoology, Botany, Physiology, Anatomy.

Each committee has a chairman and secretary : the chairman does not yet assume the function of the



SEDGWICK

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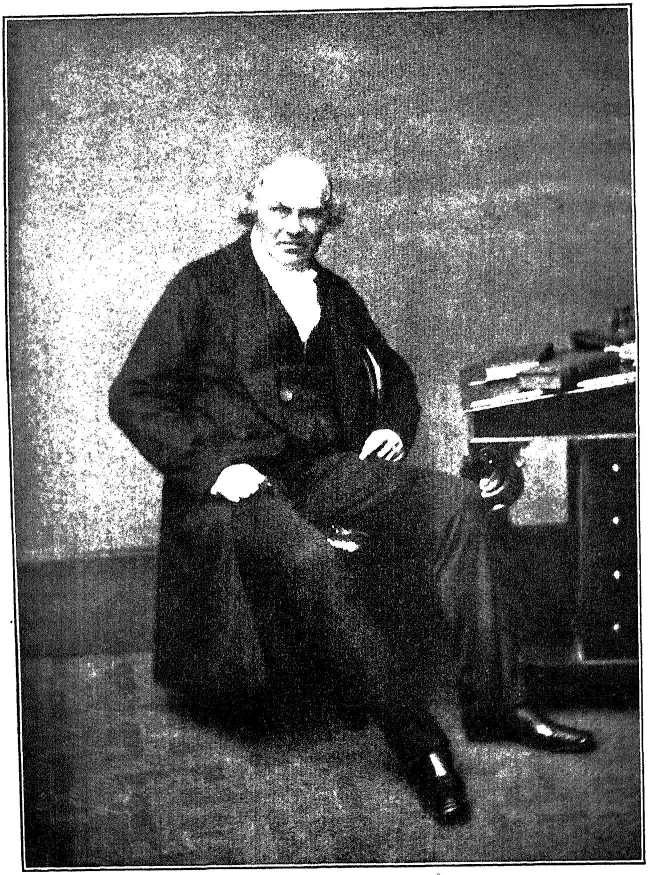

WHEWELL

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later president of a section in delivering an address. Sectional transactions of sections appear in 1832, but sections were at first formed in some measure *ad hoc* to deal with such papers as were offered and accepted. An extremely important function of the 'committees of science' (as they were termed), however, was to call 'for reports on the state and progress of particular sciences, to be drawn up from time to time by competent persons.' This practice, as we have seen (p. 25), was suggested by Whewell. Some of these reports were of extraordinary importance in their time. The Earl of Rosse in his address in 1843 pointed out 'that the man about to undertake the task of endeavouring to advance any particular branch of science may at once, by referring to one of these reports, know where to look for that information which is indispensable to success, namely, an exact knowledge of all that has been done by others.' 'Without such knowledge,' as Stokes observed (presidential address, 1869), 'there is always the risk that a scientific man may spend his strength in doing over again what has been done already.' Phillips in his address in 1865 showed that 'many of the most valuable labours of which we are now reaping the fruits, were undertaken in consequence of the reports on special branches of science which appear in the early volumes of our transactions—reports in which particular data were requested for confirming or correcting known generalisations, or for establishing new ones. Thus a passage in Professor Airy's report on Physical Astronomy first turned the attention of Adams to the mathematical vision of Neptune; Lubbock's report on Tides came before the

experimental researches and reductions, which since 1834 have so often engaged the attention of Whewell and Airy and Haughton, with results so valuable and so suggestive of further undertakings. . . . Waves—their origin, the mechanism of their motion, their velocity, their elevation, the resistance they offer to vessels of given form—these subjects have been firmly kept in view by the Association, since first Professor Challis reported on the mathematical problems they suggest, and Sir J. Robison and Mr. Scott Russell undertook to study them experimentally. Out of this inquiry has come a better knowledge of the forms which ought to be given to the 'lines' of ships, followed by swifter passages across the sea, both by sailing vessels and steamers, of larger size and greater length than were ever tried before.[1] One of the earliest subjects to acquire importance in our thoughts was the unexplored region of meteorology laid open in Professor J. Forbes's reports. Several of the points to which he called attention have been successfully attained. . . . In the same manner, by no sudden impulse or accidental circumstance, rose to its high importance that great system of magnetic observations, on which for more than a quarter of a century the British Association and the Royal Society, acting in concert, have been intent.' With these last investigations as a whole we shall deal more appropriately when considering British Association researches in Chapter VI. Against the modern extension of facilities for publication, this type of 'reports on the state of science' has to some extent lost place, but not entirely; moreover, a somewhat

[1] See, further, Chapter VI, pp. 175 and 207.

similar purpose is served by the 'review' type (as it may be called) of sectional presidents' addresses. Other considerations apart, some of the earlier of these reports form valuable historical records of the position of scientific knowledge in various departments at given moments.

In 1833 there were sections of mathematics and physics; philosophical instruments and mechanical arts; natural history, anatomy and physiology; history of science. In 1834 the sections appeared thus: mathematics and physics; chemistry and mineralogy; mathematical instruments and mechanical arts; natural history (with subsections of botany, zoology, and geology); anatomy and physiology; statistics. In 1835 we have the following sections: mathematics and physics; chemistry and mineralogy; geology and geography; zoology and botany; anatomy and medicine; statistics. At this date the sections have presidents, vice-presidents, and secretaries. In the Report for 1835 the sections first appear under distinguishing letters (though such were used earlier in manuscript minutes) and the list now ceases to undergo much annual variation. In 1836 it runs:

A. Mathematical and Physical Science.
B. Chemistry and Mineralogy.
C. Geology and Geography.
D. Zoology and Botany.
E. Medical Science.
F. Statistics.
G. Mechanical Science.

Section C became Geology and Physical Geography from 1839, and its scope was limited in consequence: in 1838 there were geographical papers on expeditions to Novaya Zemlya, the Antarctic, and the Euphrates (the last the famous ascent of the river by Lynch), besides papers on various surveys and other

topics; in 1839 communications of this character are wanting. The change clearly suggests a not unnatural conflict of interests in the section as originally constituted: it is a singular circumstance that although the change is intimated in the Report for 1838 as made by a resolution of the General Committee, such resolution finds no place in the manuscript minutes of that body. Geography does not appear as a separate section (E) until 1851. Murchison, by this time an ex-General Secretary and past President of the Association, was also a powerful supporter of the Royal Geographical Society, and he was the first president of Section E. He assisted to establish the section avowedly as a public 'draw,' and was instrumental in including in its earlier programmes such widely attractive names as Livingstone, Speke, Baker, and Burton. It was when he was staying near Bath for the meeting there in 1864 that Speke met his death through an accident with his gun while out shooting.

The early history of the Medical Science Section is chequered. It bore that title until 1844, when the section was apparently found to be too narrow in scope; moreover, the British Medical Association was founded in the year after our own (1832), and as it also is a travelling body, it is reasonable to suppose that there may have been some unnecessary duplication of interest as between our section and that association. However that may be, the section after 1844 became known as Physiology until 1847, but it was then amalgamated with zoology and botany (Section D), and so remained until 1865.

In 1866 Section D was called Biology, and had departments of physiology and anthropology. From

this year down to 1883 the chair of the section was occupied by representatives of the various departments in sequence, and the departments, or one or other of them, had chairmen of their own as well. In 1884 anthropology became the subject of a separate section (H), in 1893 physiology did the same (Section I), and in 1895 Section D became what it is now, Zoology, while Section K appears as that of Botany. Section I included with physiology the subject of experimental psychology, until in 1921 Psychology was allowed to hive off as Section J. (See p. 74.)

Section L, Educational Science, was born in 1901. Section M, that of Agriculture, was established in 1912. The subject had for some years previously been dealt with in a subsection attached to various biological sections in turn. This method is something of a makeshift; it does not remove one of the objections which is always urged against the formation of a new section—that it lays upon the place of meeting the onus of providing an additional meeting-room, and that the demands made by the Association upon such accommodation are in any event very heavy. There is, however, no record of a section once formed being afterwards disbanded, so that all may be taken to have justified their establishment at least in the view of their own supporters. And in regard to agricultural science, it may be observed that as early as 1839 a petition bearing influential signatures was presented to the General Committee requesting the establishment of a section to deal with that subject, but was rejected.

The constitution of Section A, the wide scope of which has already been indicated, was brought under

review in 1909–10, when it was suggested that a division into more than one section was desirable. This proposal was not approved, but it was laid down that so far as possible a rotation should be observed by which the three departments of mathematics, experimental science, and observational science should be represented successively in the president of the section; also that the two subjects not represented by the president in any one year should be represented by vice-presidents. Similar understandings, though on a less formal basis, are found in other sections, as in Section H, which includes ethnology and archæology as well as physical anthropology.

There has been from the earliest period a body of opinion in the Association which would limit the number of sections (*a*) from the point of view of restricting the interests of the Association to those of 'pure' science; (*b*) on the ground that the multiplication of sections implies the multiplication of communications of a highly specialised character, which belong rather to the field of specialist societies, and detract from the general public interest of an Association meeting; (*c*) on the ground, as indicated already, that a large number makes an excessive demand upon accommodation in the way of meeting-rooms, and in that way limits the number of places where the Association can meet with convenience and comfort.

It is probably true to say that the first of these objections has been urged against the formation of the majority of separate sections, down to that of Psychology (Section J) at the present time, but a broader view has prevailed, and sections such as

those of Economics and Education are at any rate not open to the charge of restricting public interest; moreover, in more senses than one, such sections have a definite function as safety-valves. The earliest recorded case of opposition by an upholder of the claims of 'pure' science is that of Whewell (always a candid friend of the Association) to the formation of Section F (Statistics, or, as it was afterwards termed, Economic Science and Statistics). The establishment of the section followed upon the presence of Quetelet, the Belgian astronomer and economist, at the Oxford meeting in 1832, and it evoked Whewell's wrath by entering upon a discussion of the Poor Laws. 'It was impossible,' he wrote, 'to listen to the proceedings of the Statistical Section without perceiving that they involved exactly what it was most necessary and most desired to exclude from the proceedings'; and again, 'Who would propose . . . an ambulatory body, composed partly of men of reputation and partly of a miscellaneous crowd, to go round year by year from town to town and at each place to discuss the most inflammatory and agitating questions of the day?' It is arguable that a discussion in a sectional meeting loses no more in value than in interest if it generates a high temperature; but, on the contrary, the inflammation for which Whewell was concerned may sometimes be salved by the measure of academic calm imported into the proceedings of an impartial body like the Association when it deals with a controversial topic. No better illustration of this can be found than an incident in the proceedings of the very section whose establishment Whewell so strongly opposed.

Early in July 1874 a strike in the linen mills of Belfast followed upon an announcement by the masters of their intention to reduce the wages of operatives, consequently upon depression in trade. The strike dragged on, with the usual accompaniment of acrimony and some measure of disorder, until toward the close of August, when the British Association held its meeting in the city. The Section of Economics, as it chanced, had upon its programme a report and two papers upon various more or less abstract industrial topics among which that of strikes was included. Here was an extraordinary opportunity for the section to put its science to practical test. It took that opportunity. The discussion which followed the report and papers centred upon the Belfast strike, for representatives of both masters and men were there by invitation, and practical suggestions were made and accepted whereby the meeting afforded an opportunity for mediation, through the agency of its principal officers. At the concluding general meeting on the following day Tyndall, the president of the Association, was able to announce that he had had the good fortune to be present at the meeting of the section referred to, that he had recognised the desire on both sides for conciliation, and that 'as the result of that discussion and a suggestion made in the course of it, he had now the most gratifying duty to announce that the act of conciliation was completed and an arrangement mutually arrived at.'[1]

The above incident was played as a trump card by the supporters of Section F when, in 1877, Francis

[1] *The Times*, August 27, 1874.

Galton returned to the charge against the section, on the grounds 'that the subjects commonly brought before [it] cannot be considered scientific in the sense of the word that is sanctioned by the uses of the British Association. Also that the section is isolated, and [as it] avowedly attracts much more than its share of persons of both sexes who have had no scientific training, its discussions are apt to become even less scientific than they would otherwise have been.' The view does not appear to have impressed itself upon Galton and his adherents that the easiest entrance to an appreciation of the work of pure science may, for the layman, lie through the gateway of science applied.

Conviviality: the 'Red Lions'

The other objections which have been indicated above to the formation of new sections lead naturally to the consideration of a new difficulty which the Association has always encountered—that of holding the balance true between the interests of the public whose friendship for science it is an object of the Association to promote, and those of the 'cultivators' of science themselves. It may be urged that these interests should be identical: in practice they are not. At an early stage we find the leaders of science embarrassed by the warmth of the public welcome accorded to them in the cities successively visited by the Association, and the view has been commonly expressed that a full measure of hospitality weighs down the scale against serious scientific labour. Even at the first meeting at York Johnston found it so: 'On future occasions it will be advisable, as is

the case in Germany, that there should be neither lectures nor scientific papers read at the evening meetings. It is rather sleepy work in most cases to rise from the dinner-table, where men have been enjoying good cheer, and to sit down forthwith to listen patiently to a scientific lecturer. There are few persons whose vigilance will not at times be overcome by this test.' It is not, indeed, given to every lecturer to make easy such a test; thus Whewell wrote in a letter on the Cambridge meeting in 1845: 'The performance in the evening was in the Senate House. I did not go there . . . Herschel read for an hour and a quarter without being heard'; and this can scarcely be an isolated instance. From time to time we come across the application to Association meetings of such terms as 'picnics,' 'junketings,' and even 'beanfeasts,' and by way of specific illustration the following note by Sedgwick on the Liverpool meeting in 1837 is worthy of quotation: [1] 'Let me then transport you to Liverpool, among mountains of venison and oceans of turtle. Were ever philosophers so fed before? Twenty hundred-weight of turtle were sent to fructify in the hungry stomachs of the sons of science. Well may they body forth, before another returning festival, the forms of things unknown! But I will not anticipate the monsters of philosophy which such a seed-time portends. The crop no doubt will be of vast dimensions.' Murchison records a similar impression. The cultivators of science themselves were divided on the question of relaxation: A. C. Ramsay notes Brewster's disgust when he and

[1] *Life and Letters*, i, 89.

Edward Forbes got up a dance in the Assembly Rooms during the Edinburgh meeting in 1850.

It was in order partly to avoid the sometimes excessive profusion of local hospitality and partly to escape from the high cost and overweight of the 'ordinary,' as the common meal supplied to visiting members at their own charges was then termed, that Edward Forbes was moved to collect a body of other young naturalists at the Birmingham meeting in 1839 and to repair for refreshment to an inn named the Red Lion. There they dined simply each day during the meeting: it was in accordance with the convivial genius of their leader that they should form themselves into a defined society for doing so, and the style of their chosen haunt supplied them with a title—the Red Lion Club. Forbes it was who gave them a species of constitution: their chairman became the Lion King; new members on admission became cubs; the organisers of the arrangements, jackals. On rising to speak (or otherwise to entertain the company) they must roar and flourish their coat-tails as an introductory ritual; similar manifestations were prescribed to the audience as conveying applause or dissatisfaction. Forbes showed a notable facility in composing and performing songs *ad hoc*: it is pleasant to record that he has had efficient successors in this and similar directions down to the present day; for the club, after an interval of lapse, has been merrily revived since the Great War. Not, indeed, on exactly the same lines as laid down by its founder, under whose auspices the club, meeting daily as we have seen, found its apartment almost crowded out toward the close of its first session: it now assembles on a single occasion

during the annual meeting of the Association, and invites its chosen menagerie, when in a free interval between the calls of official engagements the most eminent scientific supporters of our body are able to remember that *dulce est desipere in loco.* Forbes also established an association of metropolitan Red Lions in London; but that has not survived. Its mention, however, may serve as a reminder of another similar foundation, at once of greater intimacy and eminence, the famous *x* Club, which, maintained from 1864 to 1892, was limited in actual membership to nine but included five presidents of the British Association—Hooker, Huxley, Tyndall, Spottiswoode, and Lubbock. This had no direct connexion with the Association, but we read of it, free from trammels of formality, determining the destiny of the highest offices in the Association, and otherwise acting as a power behind the throne. It is only to be regretted that, as in the case of the Association itself, so many informal incidents of the gatherings of both *x*'s and Red Lions, which might have delighted the historian, must have been lost. For example, chance preserves the recollection of Hooker drinking a wineglassful of ink at a Red Lion dinner before realising the presence of the pen with which he was expected to sign the attendance book—but as a rule such episodes must remain only in the memories of those privileged to attend the functions which gave them rise.

Public Interests at the Meetings

The heavy evening meal has mercifully lost its place as the principal theme of hospitality, but the whole question of conviviality moved John Phillips

in 1848 to lay a formal expression of opinion before the Council, in which he pointed out that 'the practice of obeying local invitations has been productive of good and evil: good by the spontaneous awakening of many important places to scientific activity; evil by the introduction of elements of display, temporary expedients, and unnecessary expense.' Since these words were written there have been (if the expression be allowable) eruptions from time to time on the kindred questions of the relationship between the scientific and the social elements in Association meetings, and of the relationship between the scientific work in the sections, and the interests of the public. Of the latter question there was an investigation by the Council in 1877, when it was ruled that some surer means should be adopted of excluding 'unscientific or otherwise unsuitable papers and discussions' from the sectional meetings, and the organising sectional committees were given powers of exclusion: this investigation was chiefly noteworthy for the attack upon the Section of Economics by Francis Galton, to which reference has been made already (p. 88).

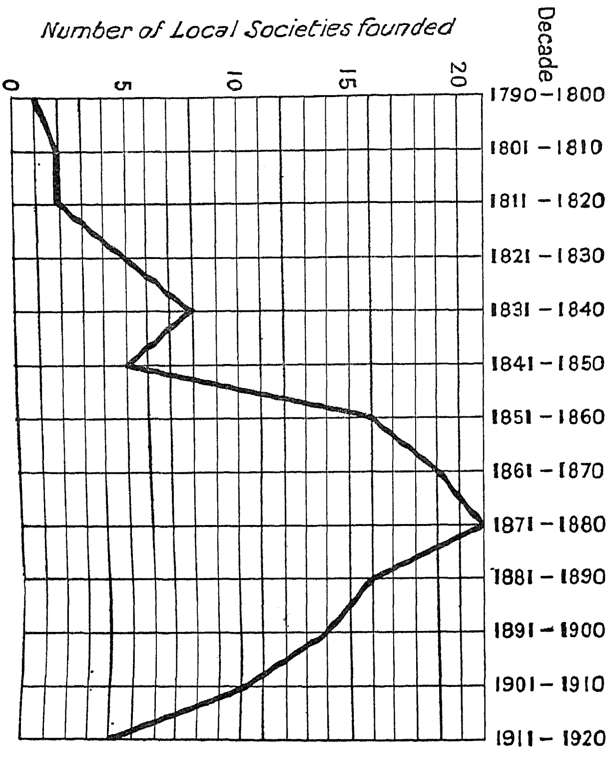
Discussion on the more frequent inclusion of popular features in the sectional proceedings was resumed in 1903, when it was left permissively to the organising sectional committees to arrange their work to consist 'as far as possible of discussions of scientific questions of general importance at the time,' and to make arrangements 'for popular lectures, demonstrations, etc.,' in the afternoons, addressed primarily 'not to men of science, but to the other members of the Association.' In the same year several more general suggestions in connexion with

the working of the annual meeting were considered without any very marked effect; save that there was expressed a sentiment, which has since matured, against allowing general excursions to conflict too strongly with the scientific interests of the meeting. In 1910 the Council again urged (but only permissively) the desirability of joint meetings between sections, and of organised discussions, and put to the committees the point that presidential addresses in subjects of kindred interest ought not to be allowed to clash in the hours of delivery. The relationship of the sections generally and the possibility of a new division were also brought under review, and in 1911 a scheme of sectional meetings was brought forward under which not all sections would necessarily assemble daily throughout the meeting, and the demands upon room-accommodation would thus be modified; but the time was not ripe. It is perhaps worth recording these discussions of reform for no other reason than to show, when periodical demands for reform are made, that the controlling bodies of the Association have not been wholly unsympathetic to such demands in the past. In preparing for the meeting in 1921 the Council, with the concurrence of organising sectional committees, authorised the general officers to arrange the hours of presidential addresses and important discussions, thus enabling the programme, as regards its salient features, to be co-ordinated, instead of being left wholly in the hands of a dozen independent committees.

Corresponding Societies

'The spontaneous awakening of important places to scientific activity,' as Phillips had it in a passage

quoted above, is exemplified, among other ways, in the foundation of local scientific societies. Delegates from such societies had been welcomed for many years at our meetings before their attendance was put



Years of Foundation of Corresponding Societies.

upon a regular footing; 'affiliation' or 'association' with the British Association was offered to local societies, and an organised Conference of Delegates of Corresponding Societies was established as a feature of the proceedings (1885). It is of incidental interest to assign the years of the foundation of 123 local scientific societies, which are now thus in

relationship with the Association, to their appropriate decades, and to show the result in a curve which reveals clearly the period of growth of scientific interests which expressed itself in the foundation of these bodies. It may well be that the existence of an active local scientific society is almost a condition precedent to a successful meeting of the British Association in any particular place; on the other hand, in some instances it seems plausible to correlate the foundation of local societies directly or indirectly with a meeting of the Association about the same time. Thus, in 1834 the Association met in Edinburgh; in that year the Edinburgh Geological Society was founded. In 1855 our meeting was in Glasgow; in 1858 the Glasgow Geographical Society was founded. The Association was at Birmingham in 1865; the South Staffordshire and Warwickshire Institute of Mining Engineers was established in 1867. The Association visited Norwich in 1868; in 1869 the Norfolk and Norwich Naturalists' Society was founded. In 1873 the Association met at Bradford; in 1875 both the Bradford Natural History and Microscopical Society, and the Scientific Association in the same city, were established; these were preceded in the intervening year by the foundation of the Halifax Scientific Society. Our Southampton meeting in 1882 was followed three years later by the foundation of the Hampshire Field Club and Archæological Society, and that at Aberdeen in 1885 by the foundation of the Buchan Field Club in that city in 1887.

In 1883 a committee under the chairmanship of Francis Galton reported to the Council on an instruction to draw up 'suggestions upon methods of more systematic observations and plans of

operations for local societies.' This committee foresaw the possibility of 'the final effect of establishing systematic local observation throughout the country, and uniformity in the modes of publishing the results,' and believed 'that the British Association is fitted by its constitution and position to become an organising centre of local scientific work.' The Committee drafted the scheme for the enrolment of corresponding societies which is still in operation, formulated the constitution of the Corresponding Societies Committee of the Association, and laid down a plan for the holding of conferences of the delegates, with the result that in 1885 Galton took the chair at the first of these conferences, which have been held each year since, and have been productive of much valuable interchange of views between delegates of the various corresponding societies and between the societies and the Association, even if the ideals of the original committee, in certain respects, still await realisation.

The published transactions of corresponding societies, which are forwarded to the Association, were formerly retained at the London office, where they formed a small library containing certain rare local publications. They were difficult of access here, and were made over in 1921 to the library of the British Museum (Natural History). It may be added that foreign scientific publications which are received by the Association, together with others not coming from corresponding societies, are forwarded to the library of University College, Gower Street, and members of the Association have access to these, under an arrangement which has existed since 1904.

Membership of the Association

We have seen (p. 23) that, as originally proposed, membership of the Association involved this limited amount of qualification—that the applicant should already be a member of a 'philosophical' society. This qualification was maintained for many years in theory, though it vanished in practice, and membership actually came early to involve, as it does still, 'no technical qualification.' In 1845 the Council laid down conditions and terms of membership which, it is worthy of remark, survived until 1919; and even then (when the life composition fee was raised, and a special rate of subscription was instituted for members desiring to receive the Annual Report) it still remained, and remains, possible to attend a meeting for the same fee (£1) which was demanded in 1831. The Council and General Committee, indeed, went farther in 1919, despite the vastly decreased value of money, for they removed the entrance fee of £1, which had till then been required of members as distinct from associates. It can at least never be said that the Association has priced its service to the public too highly. From 1845 down to 1919 a class of 'associates' was maintained, who joined solely for the purpose of attending a meeting, and held no rights of receiving the report, holding office, or serving on committees. The recommendation of a member was originally required for admission to the associateship, but this ceased to be demanded in practice, and finally the class of associates was abolished too, for the distinction between the two classes ceased to serve any useful purpose.

Of more interest, as a matter of history, than these

administrative details is the position of women in the Association. We have already seen (p. 16) that the admission of women to scientific meetings was frowned upon by early supporters of the Association, and we have quoted Buckland's strictures upon their attendance. But the administration apparently failed to practise what it preached as to regulating women's attendance, for Hooker, writing of the Newcastle meeting in 1838, remarks that in the Natural History Section 'there were not above fifty people in the room, and almost no ladies; those few who were there had come in by accident, and I was afterwards much surprised to hear that ladies were precluded from attending this section of Botany and Zoology on account of the nature of some of the papers belonging to the latter division.' [1]

Again, in a letter on the same meeting,[2] Sir John Herschel writes to his wife:

'And, by the bye, though one should not tell one's own good things, here is one so good that you must have it! Sedgwick, in his talk on Saturday, said that the ladies present were so numerous and so beautiful that it seemed to him as if every sunbeam that had entered the windows in the roof (it is all windows), had deposited there an angel. Babbage, who was sitting by me, began counting the panes, but, his calculation failing, he asked me for an estimate of the number. "I can't guess," was my answer; "but, if what Sedgwick says be true, you will admit that for every little pane there is a great pleasure."'

[1] *Life and Letters of Sir J. D. Hooker*, by Leonard Huxley, i, 34. This was Hooker's first meeting, and he found that 'the scientific department fell far behind the amusement and eating.'

[2] Quoted in *Life and Letters of Adam Sedgwick*, i, 515.

INDIAN INSTITUTE OF SCIENCE LIBRARY

Ladies were not, in point of fact, admitted by purchased ticket until 1843; a special 'ladies' ticket' was then introduced, but this was found to be not to the taste of some of the recipients, since in 1869 a Miss Becker and others presented a memorial to the Council asking that these tickets should be similar in form to those of ordinary members and associates. It can no longer be ascertained whether it was a cause or an effect of this memorial that the ladies' transferable ticket which survived until 1919 was adorned with a fair garland of vines; but the memorial went farther and demanded an answer to the question whether ladies were eligible for election to the sectional committees, the General Committee, and other offices. The Council coldly replied that 'there were no rules of the Association by which ladies were precluded from serving upon committee if elected in the ordinary way'; and the question remained quiescent until 1876, when the Council appointed, and adopted the report of, a committee which stated that 'it does not appear to have been the practice of the Association to admit ladies to election as officers, or upon committees,' and that 'it does not appear that any case has been made out for altering the practice.' Again, in 1885, the General Committee referred the same question to Council; and again the Council appointed a committee, which this time reported in the ladies' favour; nevertheless the Council were 'of opinion that the time has not yet come when it would be for the advantage of the Association to depart from the established custom.' As late as 1897, a woman was excluded from a sectional committee, after nomination, on the strength of the Council's ruling twelve

years earlier. But the dispute, as such, faded out, and the Council's objection finally disappeared by default: at length, in 1913, Miss Ethel Sargant took her seat as the first sectional president of her sex (in the Botanical Section), and in the following year the Council welcomed Miss E. R. Saunders, of Newnham College, as one of its members.

Public Lectures

The British Association has in no department of its labours more clearly carried out its founders' charge 'to obtain more general attention for the objects of science,' than by the endeavours it has made to bring those objects, in successive places of meeting, before the classes of citizens whose interests or circumstances do not permit of their becoming members of the Association. Long before any systematic arrangements of 'public' lectures were brought into being, we find distinguished members of the Association taking advantage of its meetings to widen the appeal of science. For example, Sir John Herschel, in a letter to Lady Herschel from which quotation has previously been made (p. 99), writes of Sedgwick's activities at the Newcastle meeting in 1838:

'All the show here is over. It has been by far the most brilliant meeting of the Association, and in all the public proceedings perfect good taste has reigned. Sedgwick wound up on Saturday with a burst of eloquence (something in the way of a sermon), of astonishing beauty and grandeur.

'But this, I am told, was nothing compared to an out-of-door speech, address, or lecture, which he

read on the sea-beach at Tynemouth to some 3000 or 4000 colliers and rabble (mixed with a sprinkling of their employers), which has produced a sensation such as is not likely to die away for years. I am told by ear- and eye-witnesses that it is impossible to conceive the sublimity of the scene, as he stood on the point of a rock a little raised, to which he rushed as if by a sudden impulse, and led them on from the scene around them to the wonders of the coal-country below them, thence to the economy of a coal-field, then to their relations with the coal-owners and capitalists, then to the great principles of morality and happiness, and at last to their relation to God, and their own future prospects. . . .'

Murchison, writing of the meeting at Glasgow in 1840, recalls 'the glorious day at Arran, when I lectured to a good band of workmen, with every peak of Goatfell illumined, and marched up at close of the day to Brodrick Castle, with the Heir of the House of Douglas, preceded by the piper.' [1]

Again, at the Manchester meeting in 1842, we find Sedgwick [2] at an Association dinner describing 'a walk he had taken through the streets of Manchester, amidst the smoke of chimneys and the roar of engines;' and then he came to speak of the artisans:

'In talking to men whose brows were smeared with dirt, and whose hands were black with soot, I found upon them the marks of intellectual minds, and the proofs of high character; and I conversed with men who, in their own way, and in many ways bearing upon the purposes of life, were far my

[1] *Memoirs*, i, 303. [2] *Life and Letters*, ii, 46.

superiors. I would wish the members of the British Association to mingle themselves with these artisans, and in these perhaps overlooked corners of our great cities; for, as I talked with them, the feeling prevailing in my mind was that of the intellectual capacity in the humbler orders of population in Manchester. This is a great truth, which I wish all the members of this Association to bear away with them, that while the institutions and customs of man set up a barrier, and draw a great and harsh line between man and man, the hand of the Almighty stamps His finest impress upon the soul of many a man who never rises beyond the ranks of comparative poverty and obscurity.

'Do not suppose for a moment that I am holding any levelling doctrines. Far from it. I seek but to consolidate the best institutions of society. But I do wish that the barriers between man and man, between rank and rank, should not be harsh, and high, and thorny; but rather that they should be a kind of sunk fence, sufficient to draw lines of demarcation between one and another, and yet such that the smile of gladness and the voice of cheerfulness might pass over, and be felt and heard on the other side.'

It was more than twenty years, however, before this channel of communication between the Association and the public was formally opened. During the earlier 'sixties, it is noticeable that the Association was entering less widely into relations with governments and public bodies than it did before or subsequently. As we find elsewhere (p. 226), this particular form of public activity on the part of the Association was almost confined, about that time, to furthering the development of scientific education.

It was as if science, having (temporarily at least) consolidated its own position in the eyes of the public services, and having at length gained a satisfactory measure of recognition from them, was now seeking to extend its direct relations with the public. However that may be, it was in 1866 that two resolutions were sent up to the Council, from the sections of Physics and Economics respectively, to the effect that 'a popular lecture for the benefit of the working classes' should be delivered at each annual meeting. One of these resolutions, indeed, included the limiting clause, 'when the Association meets in large manufacturing towns'; and a committee of the Council, which reported favourably on the scheme, contained the proviso, 'should a request be made for such a lecture by the executive committee in any large town about to be visited.' It is, therefore, worth observing that once the formal series of 'lectures to the operative classes' (as they were called) was started, as it was in 1867, it was only broken, apart from overseas meetings when special arrangements prevailed, in three years—1871 at Edinburgh, 1878 at Dublin, and 1899 at Dover.

The series started well, with lectures by Tyndall at Dundee (1867), on 'Matter and Force,' and Huxley at Norwich (1868), on 'A Piece of Chalk.' Huxley was enthusiastically in favour of the movement: as early as 1855 he had opened at the Jermyn Street Museum his own regular series of lectures to working men, which afterwards became famous; and to Tyndall, in reference to the Dundee lecture, he wrote: 'You have inaugurated the working men's lectures of the Association in a way that cannot be improved. And it was worth the trouble, for I suspect they will

become a great and noble feature in the meetings.'[1] Of his own lecture in 1868, his biographer says:[2] '. . . a perfect example of the handling of a common and trivial subject, so as to make it "a window into the infinite." . . . This lecture . . . together with two others delivered this year, seem to me to mark the maturing of his style into that mastery of clear expression for which he deliberately laboured, the saying exactly what he meant, neither too much nor too little, without confusion and without obscurity.' The lectures, as a whole, have been exceedingly successful: the popular audiences have shown no sign of neglecting sciences when addressed to them on an acceptable topic through a competent mouthpiece. To take a single example out of many, it is recorded[3] that Silvanus Thompson at Cardiff (1891) had a crowded audience of miners who were brought by special trains to hear him speak on the uses of electricity in mining; again, he held a Bradford audience of 3500 for an hour and three-quarters (the length of time is a tribute to his genius), while he discussed the applications of electricity to industry as a national question, and at the close elicited a 'manifestation of feeling . . . such as is generally associated with a great political meeting, rather than with a scientific lecture.' A series of great names—Lubbock, Preece, Ayrton, Evans, Bramwell, Ball, and

[1] *Life and Letters of Huxley*, i, 292.

[2] *Op. cit.* i, 297. In the year of his presidency (1870, at Liverpool) Huxley, with others, were taken under police escort to view some of the worst slums in the city. This visit is evidence of a deep interest in the betterment of conditions of life of the poorer classes of which the lectures here referred to are another form of expression.

[3] *Silvanus Phillips Thompson: His Life and Letters*, by J. S. and H. G. Thompson. 1920.

others—carries the list of lecturers 'to the operative classes' down to the year 1911, after which, again beginning (very appropriately) with a meeting at Dundee, there appears an alteration of practice and an extension of principle. It had become evident that with changing times the limitation indicated by the title of the series had ceased to be appropriate; and there was no reason on the Association's side why the number of lectures should be limited to one each year. In 1910 one of the evening discourses to the Association (that by Professor W. Stirling[1] on 'Types of Animal Movement') had been repeated 'to the public' at the place of meeting, Sheffield. The Council therefore willingly accepted a proposal to alter the title of the series to Public or Citizens' Lectures, and undertook to appoint any number of lecturers for which a local executive committee might ask, and from 1912 onward there have been (1921) three or more public lectures at each meeting. The Workers' Educational Association, the foundation of which, in 1903, indicates the growth of demand on the side of the workers for such help as can be given through the British Association's public lectures, has collaborated in the local arrangements for these, and, in some instances, has suggested topics which would be specially acceptable. The Association and the lecturers provide these lectures from a wholly disinterested desire for the advancement of science, and thereby demonstrate that sense of class-union which it was Adam Sedgwick's wish to foster. And yet it was possible—and at no remote date—for a borough councillor purporting to represent labour,

[1] Professor of physiology and histology, Manchester University.

when his council had a meeting of the Association under discussion, to stigmatise our body as an association of the rich, whose proceedings were of no interest or value to his class!

The Presidency of the Association

In early years the Association followed the German model in generally electing to the chair a representative of the place of meeting. This was sometimes also a noteworthy figure in science, as in the cases of Buckland at Oxford (1832) and Sedgwick at Cambridge (1833). Attention was also paid, in accordance with the spirit of the time, to social rank; and thus among the first ten presidents we find a duke, an earl, two marquises, and a viscount. These were not necessarily distinguished as men of science; thus, the Marquis of Breadalbane, presiding at the Glasgow meeting in 1840, left the preparation of an inaugural address to the General Secretaries, a duty upon which Murchison commented in a letter to Whewell: 'It is my fate to have, in conjunction with Sabine, to prepare a note of the King's speech, to be read at Glasgow.' It was not long, however, before these practices gave way to the recognition of the presidency of the British Association as one of the highest honours which science could bestow upon its cultivators; and as a corollary, it also became an accepted view that the locality of a meeting (unless in exceptional circumstances) should welcome the president as a distinguished visitor, rather than that he should welcome the Association in his own place. The presidential address, in place of a comparatively brief speech of goodwill, possibly

of retrospect over the preceding year's scientific advancements, possibly of anticipation of the advantages to accrue from the meeting it was inaugurating, became what it still is, the principal public scientific pronouncement of the year. Out of this condition grew the impression to which Hooker referred in his address in 1868, 'that the address should either be a scientific *tour de force*, philosophical, and popular, or a résumé of the progress of one or more important branches of science.' Hooker, it may be added, disclaimed ability 'to fulfil either of these requirements,' although the disclaimer was possibly discounted when he proceeded:

'I propose to offer you some remarks upon several matters to which the attention of your committee was directed when at Dundee, and then upon some of the great advances that have been made in botany during the last few years; this will infallibly drag me into Darwinism: after which I shall allude to some matters connected with that dawning science, the Early History of Mankind.'

Hooker, therefore, did not fall much short of the standard demanded by the second alternative 'impression' to which he referred. As to the first, the *tour de force*, as he termed it, he had in mind, no doubt, the type of address in which leaders of scientific thought have made suggestions, or brought forward theories, not necessarily associated directly with their own labours, but bearing upon some common subject or aspect of daily life, and therefore to be seized upon by the unscientific hearer or reader as a matter understandable and debatable. Thus Armstrong, in 1863, took occasion to estimate the

duration of the coal supplies in the mining fields of the British Isles, and passed on to consider water-power and other alternatives to the use of coal. William Ramsay in 1911 did the same. Crookes's address in 1898 is still in demand by inquirers into the subject of the world's wheat supplies, because he formulated an estimate of them (modified though it has been by later extensive developments in agriculture), and foreshadowed the failure of available wheat-lands to maintain their fertility: he then pointed out how chemical science might aid in restoring that fertility. Armstrong again, in the address already cited, incidentally adverted to our laborious method of writing, and pleaded for the common adoption of a new script tending in the direction of shorthand in so far as it would use single symbols for the commonest syllables. He was also eloquent in favour of the adoption of a metric system of weights and measures—a subject which other presidents have not neglected. Out of Thomson's (Kelvin's) monumental address in 1871 the passage which most impressed itself upon the popular imagination was that in which he asked how life originated upon the earth, and offered, as a not unscientific hypothesis, the possibility of its meteoric origin.

Such addresses as these, whatever their value otherwise, demonstrate to all men that science is thinking with and for them, about matters which must interest and most deeply concern them. Others may arrest the untrained listener mainly through the profundity of thought which they reveal, and the beauty of its verbal expression. Of such character is Tyndall's famous address at Belfast in 1874, though

different effects, in this instance, were produced upon the minds of some of his audience.[1] No further analysis of the addresses must be ventured upon here; but it should be remembered that they have been unrelieved, save very rarely, by any form of ocular demonstration or illustration, and are presented under (and in some cases, it may be said, have to contend against) circumstances of extreme formality. Perhaps few would have this otherwise; but A. C. Ramsay showed signs of revolt against the conservative practice. He, who at the Glasgow meeting in 1840 had given his first scientific paper on a geological model, maps, and sections of the island of Arran, and made there some of the friendships which had the most profound influence on his career, ascended to the presidential chair of the Association forty years after, at Swansea. He wrote an address, indeed, and it was published, but he did not read it. Instead, he spoke from a few notes, and 'his lively inflections of voice, marked Scottish accent, and energetic gestures . . . were a novel and not unwelcome variation from the more

[1] Sir Oliver Lodge thus recalls impressions of the Belfast meeting: 'Tyndall's address lasted nearly two hours, and towards the end the atmosphere began, metaphorically, to smell of brimstone. Some people began to go out, while others looked at each other in a horrified manner. The impression was intensified by Huxley's most eloquent discourse on animal automatism, in which he included man among the other animal automata; and on the Sunday following every pulpit in the city seemed to be fulminating anathemas at the men of science, and Huxley was challenged by one of the Ministers at the railway station on his departure. Huxley's lecture was a marvellous performance, delivered without a note and with hardly a movement of the body, the flow of language seeming to involve no sort of hesitation or difficulty. The other evening lecture was given by Sir John Lubbock on wild flowers in relation to insects, and Tyndall's motion for a vote of thanks was eloquent and picturesque.'

usual formality of the presidential address.'[1] It is easy to credit that the formal reading of an address may in some instances be detrimentally destructive of the speaker's personality. The practice, recently introduced, of leaving sectional presidents free either to read their addresses or to speak upon the topics of them, may lead presidents of the Association also to recall, in their discretion, the distinguished precedent set by Ramsay in 1880.

At each meeting of the Association the reception-room or other convenient place is adorned with a series of banners, some of which are illustrated here. They bear the names of successive presidents and the places of meeting where they presided. Sometimes the president's coat of arms is shown; sometimes that of the place of meeting; sometimes an emblematic device. This variety makes for interest: the fact that variation of size has been permitted is perhaps less fortunate. The series was originated by the Historic Society of Lancashire and Cheshire: the idea of it is attributed to the Rev. Canon Abraham Hume, a well-known antiquary, one of the founders of that society in 1848. The banners appear to have been first made for the Liverpool meeting of the Association in 1854. The original series of twenty-four then displayed in the Philharmonic Hall were made on a standard pattern 'of white silk, and emblazoned in a very correct and elegant style,' as a local report of the meeting has it. Hume was a local secretary for the meeting of the Association in Liverpool in 1870. Through him the Historic Society interested itself actively

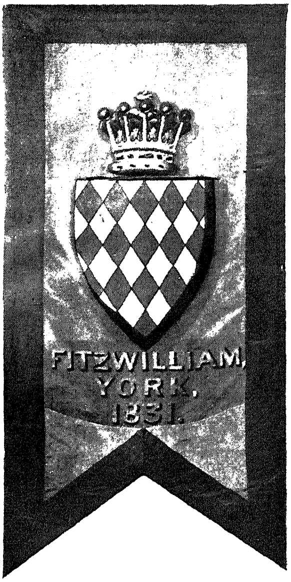
[1] Geikie, *Memoir of Sir A. C. Ramsay*, p. 347.

in this meeting. Diplomas of honorary membership and gifts of books were presented to Huxley as President of the Association, to Stokes and Hooker as his immediate predecessors in the chair, to Tyndall and Rankine as deliverers of the evening discourses, and to Lubbock as lecturer to the 'operative classes.'[1] Huxley also received from the society a commemorative bowl. For many years the series of presidential banners remained in the society's ownership, a new banner being added and the whole lent to the Association for exhibition each year. This cumbrous process was terminated in 1893, when the Association acquired the banners from the Society by purchase. The series has been maintained since then either by presidents themselves, or by the Association, or by local committees at places of meeting.

Royal Interest

This chapter may be fittingly concluded with a reference to the interest which has been graciously expressed from time to time by the Royal Family in the work of the Association. The individual scientific interests of certain members of that Family in earlier days will appear elsewhere; but active royal participation in the meetings was initiated by the Prince Consort. He was no stranger to the Association when he occupied its chair at the Aberdeen meeting in 1859. Thus Murchison, as President at the Southampton meeting in 1846, stated that that meeting would be 'rendered memorable in our annals by the presence of the illustrious Consort [illegible] beloved Sovereign, who, participating in our

[1] See p. 101.



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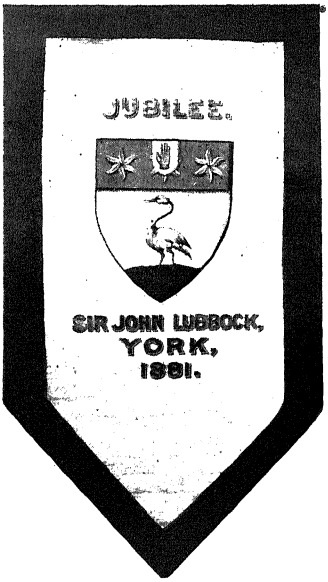

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(3)

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PRESIDENTIAL BANNERS

(1, 2). The Banners of the First and Jubilee Meetings.
(3, 4). Banners during and following the Great War.

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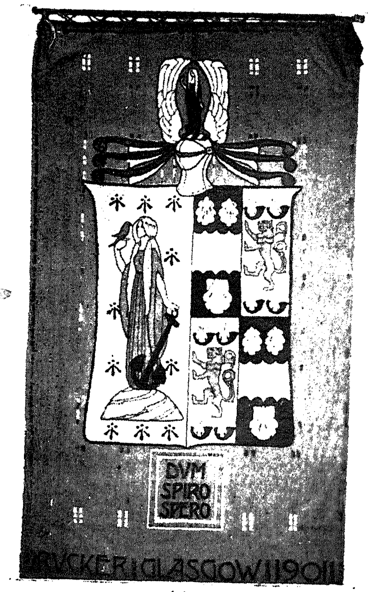

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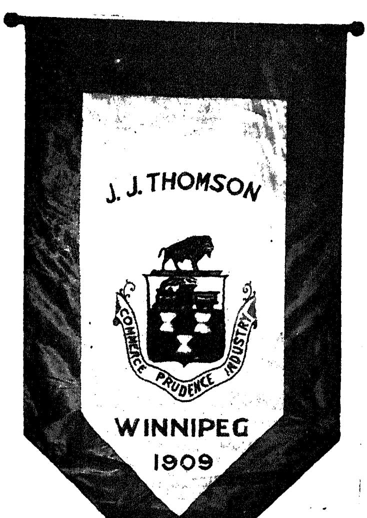


(7)

(8)

PRESIDENTIAL BANNERS

(5, 6). Obverse and reverse of a fine embroidered banner, executed locally.
(7). Another example of local embroidery.
(8). An embroidered banner on a ground of night-sky blue. The bar at the head represents the colours of the spectrum; at the foot is the constellation of Orion.

Facing p. 113]

pursuits, in some of which His Royal Highness is so well versed, thus demonstrates that our Association is truly national,' and so forth. Murchison no doubt felt that this mark of favour went far to discountenance the ignorant opposition to the Association which, as we have seen (p. 36), somewhat disconcerted him about this time. Prince Albert, again, was at the Ipswich meeting in 1851, when he recorded his visits to five sections in succession between 11.30 and 2.30 on one day, in a letter to Queen Victoria, to which was appended what he termed 'a plan of the battle'—a tabular summary showing his progress and the topics which he heard discussed.

The prospect of his own appearance in the presidential chair evidently caused him some apprehension: it is recorded that he 'dreaded failure'; but Queen Victoria was able to write to King Leopold that 'Albert left me yesterday morning for his great undertaking at Aberdeen, which, I have heard by telegraph, went off extremely well.' He conveyed in his address a very clear message from the Queen: 'I saw in my acceptance [of office] the means, of which necessarily so few are offered to her Majesty, of testifying to you, through the instrumentality of her husband, that your labours are not unappreciated by your Sovereign, and that she wishes her people to know this as well as yourselves.' The Prince was no mere figure-head: the Council, during his year of office, met under his chairmanship at Buckingham Palace.

The Royal Patronage was extended to the Association by King Edward VII in 1904, and was continued by his successor. To him the Association

addressed loyal messages on his accession to the Throne; at the first opportunities after the outbreak and the conclusion of the war (1915 and 1919), and again in 1920, when, meeting in Wales (Cardiff), the members present offered their congratulations upon the successful labours of the Prince of Wales during his imperial tour.

CHAPTER IV

ANNUAL MEETINGS: THE ASSOCIATION OVERSEAS

Places of Meeting—Attendance at Meetings—Jubilee Meeting, 1881—Overseas Meetings: Montreal, 1884—Toronto, 1897—South Africa, 1905—Winnipeg, 1909—Australia, 1914.

Places of Meeting

The British Association, at the time of writing (1921), has held eighty-nine annual meetings since and including that in 1831; in two years during the Great War (1917–18) no annual meeting was held, but the General Committee met in London for the despatch of essential business, and the Conference of Delegates of Corresponding Societies maintained activity. The meetings have been held at the following places (and invitations which at the time of writing have been accepted for two future years are included):

Five Times

Birmingham (1839, 1849, 1865, 1886, 1913).
Edinburgh (1834, 1850, 1871, 1892, 1921).
Liverpool (1837, 1854, 1870, 1896, 1923).

Four Times

Cambridge (1833, 1845, 1862, 1904).
Dublin (1835, 1857, 1878, 1908).
Glasgow (1840, 1855, 1876, 1901).
Manchester (1842, 1861, 1887, 1915).

Newcastle-on-Tyne (1838, 1863, 1889, 1916).
Oxford (1832, 1847, 1860, 1894).
York (1831, 1844, 1881, 1906).

Three Times

Belfast (1852, 1874, 1902).
Bristol (1836, 1875, 1898).
Canada (Montreal, 1884; Toronto, 1897; Winnipeg, 1909).

Twice

Aberdeen .	(1859, 1885).	Leeds . .	(1858, 1890)
Bath . .	(1864, 1888).	Nottingham .	(1866, 1893)
Bradford . .	(1873, 1900).	Plymouth .	(1841, 1877)
Cardiff . .	(1891, 1920).	Sheffield .	(1879, 1910)
Dundee . .	(1867, 1912).	Southampton	(1846, 1882)
Hull . . .	(1853, 1922).	Southport .	(1883, 1903)
Ipswich . .	(1851, 1895)	Swansea .	(1848, 1880)

Once

Africa, South .	(1905).	Dover . .	(1899).
Australia . .	(1914).	Exeter .	(1869).
Bournemouth .	(1919).	Leicester .	(1907).
Brighton . .	(1872).	Norwich .	(1868).
Cheltenham .	(1856).	Portsmouth .	(1911).
Cork . . .	(1843).		

Attendance at Meetings

The total attendances at four of the meetings in early years are not recorded. Apart from these, we find the following to be average numbers of attendance: at 13 meetings in Scotland, 2133; at 24 in the North of England (Northumberland, Yorkshire, Lancashire), 1955; at 12 in the Midlands and East Anglia (excluding Oxford and Cambridge), 1697; at 7 in Oxford and Cambridge, 1608; at 14 in the South of England, 1683; at 6 in Ireland, 1929; at 4 in Wales, 1152. The average for 5 meetings

overseas is 2356, but this includes the figure for Australia (5044) where proceedings took place in five cities (see p. 134). Apart from this meeting, the largest recorded attendances are at Manchester (3838 in 1887; 3138 in 1861), at Newcastle-on-Tyne (3335 in 1863), and at Liverpool (3181 in 1896): and these and the averages given above suggest that the spiritual home of the Association is in Scotland and the North of England. Certainly there is a measure of geographical control over the figures, and a charge brought sometimes against the Association that its attendances do not show a progressively upward tendency is therefore not justified. The annual meeting is held on invitation from the place concerned; sometimes such invitations have been inspired from headquarters, but, so far as appears, rarely, and no period is found at which a scarcity of invitations seems to have been apprehended. Rather, it has not infrequently happened that the General Committee (or the officers acting for them in advance) have found need to exercise tact in discriminating between competing claims.

Jubilee Meeting, 1881

Special notice is due to the jubilee meeting in 1881. It was held, fittingly, at York as the birthplace of the Association, and a powerful body of eminent scientific men, from home and abroad, gathered for the occasion. Lubbock was president, and a past-president of the Association was found to take the chair of every section except that of Economics, over which Grant Duff, Governor of Madras, presided. Thomson (Kelvin) was president

of the mathematical and physical section; Williamson of the chemical; A. C. Ramsay of the geological; Owen (president of the Association as far back as 1858) of the zoological; Armstrong of the mechanical. The geographical section might have proved difficult to supply with such a leader, but that Hooker was amply qualified and willing to act. It is incidentally recorded that at an evening assembly in the art gallery a novelty was introduced in the use of electric incandescent lamps. May the centenary meeting in 1931 prove no less brilliant! John Perry, the General Treasurer whose loss the Association mourned in 1920, was wont to picture this as the first meeting to be held in London.

With other individual meetings at home we need not deal specifically; but the meetings overseas call for consideration in detail.

Overseas Meetings: Montreal, 1884

A proposal that the Association should hold a meeting outside the British Isles is first encountered when Captain Bedford Pim gave notice to the General Committee in 1881 that he would move for a meeting in Montreal. He ascertained, through Bishop J. T. Lewis of Ontario, that the project would receive the cordial and practical support of the Dominion Government. Correspondence which took place between the Marquess of Lorne as Governor-General of Canada and William Spottiswoode, who had been president of the Association in 1878, with reference to the possibility of a meeting at Montreal, was reported to the Council in 1882. In that year the American Association for the Advancement of Science (founded

in 1848) met at Montreal, and an endeavour was made to attract British scientific men to the meeting by offering special arrangements for the Atlantic passage, but with little success. The Governor-General hoped for a visit from the British Association in 1883, during his term of office, when, moreover, it was contemplated to form a Canadian Association. An invitation elsewhere, however, had already been accepted for 1883, by the General Committee. The situation was subsequently complicated by the withdrawal of this invitation, but there were other competing claims, and the General Committee, at one of its meetings in 1882, (*a*) received a proposal that the meeting in 1883 should be held in Montreal, (*b*) rejected an amendment that it should be held in the United Kingdom, (*c*) reversed its own decision by resolving that it should be held in Southport, and (*d*) resolved that the meeting in 1884 should be held in Montreal. Opposition was strong. One hundred and forty-one members of the General Committee signed a memorial to the Council, protesting against the principle of an overseas meeting on the main grounds that the founders of the Association never contemplated meetings outside the United Kingdom, and that the holding of a meeting at so distant a point as Montreal would bear hardly upon a number of life members and other regular members who would be unable to attend and for whom the continuity of the meetings would consequently be broken, with injury to the business of the Association; finally, they urged the danger of the precedent. Opposition was voiced elsewhere with greater freedom than would befit a formal memorial: the General Committee was suggested to have acted *ultra vires*;

and *The Times*, in a leader, intimated (among other objections) that the meeting in Canada would be merely a glorified picnic of important men of science, who could have no serious purpose in visiting Canada, a land not great in science, so that humbler men and less advanced thought would serve equally well for her instruction; the more eminent supporters of the visit desired to make it in order that they might have an agreeable outing and be wondered at, and so forth. The *Toronto Mail* rated Canadian interest rather low; it foresaw audiences small and uninspired: 'the mind of the average fashionable gathering is not scientific; it is not even literary in the most meagre sense; it very hazily comprehends Oscar Wilde; it fails to grasp Professor Tyndall or Professor Huxley.' Whatever the merits of the opposition, some of its supporters clearly protested too much. It may be observed in passing that the opposition's view of the founders' intention to limit meetings to the United Kingdom is at least open to doubt: in an account of the very first meeting (1831) which appeared in the *Edinburgh Journal of Science*, Vol. XI (N.S.), it is stated that 'the foundation of a general national institution has been laid, which, fixed to no spot, is free to range from city to city of this great empire'; though it is fair to add that this statement is not from an official document and might be ascribed to the personal exuberance of the author. However, we do not discover anything in the archives specifically to controvert it, and the Council did not find, in the memorial referred to, ground for action adverse to the General Committee's decision. But, after ascertaining the probable cost of the visit to ordinary members of the Association and the number to whom

it would be possible to offer facilities, the Council instituted an inquiry of all members on the books, and the replies 'were such as to remove all doubts as to the representative character' of the party which would attend the meeting in Montreal. As for new members, it was found necessary that the Council should scrutinise applications for membership made in England during the year preceding the meeting. The number of members who made the journey overseas was 910. The success of the meeting was assured in advance, and at a later date Playfair (presidential address, 1885) went so far as to assert that it 'even marked a distinct epoch in the history of civilisation.'

It is unnecessary here to detail all the special arrangements for the meeting, but they set a standard for future meetings overseas. The Dominion Government devoted a grant of $20,000 toward the travelling expenses of visiting members, while both the Government and the Civic Council of Montreal financially supported the Local Executive Committee. The transatlantic shipping companies offered reductions in fares; the Canadian Pacific and other railway companies offered free passes or low rates. The Canadian Pacific Company, in particular, provided for an excursion of a selected body of members from Montreal to the then railhead at Laggan in the Rocky Mountains, and back, in the course of which the party was welcomed at a succession of new-born townships of the west, one of which, Winnipeg, itself was subsequently (in 1909) to receive the Association. Apart from this excursion, other members had ample opportunity for travelling in eastern Canada, visiting points of special scientific interest. The scientific

work of the meeting was carried out in Montreal on the usual lines under the presidency of Lord Rayleigh.

It is impossible fully to assess the scientific results of this or any overseas meeting of the Association. Important results may spring, and have sprung, from conversations at chance meetings between visiting and local scientific men: such results may, more probably than not, go unrecorded, though there is material to afford an indication of their value in the case of a later overseas meeting, that in Australia (p. 138). For such intercourse the Montreal meeting afforded opportunity not only between Britons and Canadians, but also between both and Americans, for the Council of the British Association invited the standing committee and fellows of the American Association 'to visit Montreal on the footing of Honorary Members,' and the American Association arranged its meeting at Philadelphia in 1884 on such a date as would afford opportunity for members of the British Association to attend it after their own meeting.

Visiting members of the British Association returned home full of a new knowledge of the scientific and economic potentialities of the Dominion; evidence of this appears in such unofficial publications as Sir Henry Lefroy's paper before the Royal Colonial Institute, Professor Boyd Dawkins' letters to the *Manchester Guardian*, and Mr. R. D. Pullar's report in the *Perthshire Constitutional.* On the Canadian side, not only was a special handbook for the Dominion issued under the editorship of Mr. S. E. Dawson, but an important collection of papers by Canadian and American authorities on Canadian Economics, obtained at the instance of the Com-

mittee of Section F, was published by the Local Executive Committee out of funds remaining in its hands after discharging liabilities connected with the meeting. The remaining surplus of $1500 was presented to McGill University, Montreal, 'in recog nition of, and compensation for, their liberality in placing the buildings and grounds of the University at the disposal of the Association. . . . It was understood that the sum should be invested to form the nucleus of a British Association Apparatus Fund, the income from which should . . . be used to buy philosophical apparatus.' The University also benefited (as it well deserved) in another direction. During the meeting a proposal was made to commemorate the visit by founding a gold medal to be awarded annually for proficiency in applied science. A sum exceeding £500 was subscribed by members of the Association and transmitted to the University for investment, and the medal was designed, on the Council's instruction, by Mr. A. Wyon.

Some indication of scientific results of the first overseas meeting is afforded by committees appointed to deal with, and resolutions passed with reference to, Canadian scientific questions. Committees were appointed (1) to investigate and publish reports on the physical characters, languages, industrial and social condition of the north-western tribes of the Dominion, (2) to promote tidal observations in Canada, (3) to report on the aid given by the Dominion Government and the Government of the United States to the encouragement of fisheries, and to the investigation of the various forms of marine life on the coasts and rivers of North America. Resolutions were passed requesting the Council to communicate

with the Dominion Government as to (1) the importance and improvements of tidal observations on the Canadian Atlantic coast, (2) encouraging investigation of the native tribes of the Dominion. The committee on the Indian tribes produced in succeeding years a specially full and valuable series of reports, and the resolutions on which the Council took action, while not immediately productive of the results desired, indicated directions for further effort in the future. Reference may also be made here to Sir Oliver Lodge's evening discourse on dust, since the experiment of the electric deposition of dust shown on that occasion became the foundation for important industrial obligations in America and elsewhere under the name of the Lodge-Cottrell process.

What may be termed the side-issues of British Association meetings sometimes prove to be as important as any incident of the meetings themselves, or more so; but the connexion may be difficult for the historian to trace. The Montreal meeting, however, supplies a good example. It happened that certain heads of University Colleges in the United Kingdom made the journey to attend the meeting; among them William Ramsay, then head of University College, Bristol. It was he who, during the journey, promulgated among those in similar positions the idea of holding informal meetings at regular periods, in order to ensure common action in such matters as pressing the claims of such institutions upon the Government. By this means, after not many years, the financial position of these colleges was materially improved, and a majority of them became independent universities.

We scarcely dare to regard the famous series of Baltimore lectures, delivered by Sir William Thomson (Kelvin), as a ' side-issue ' of the Montreal meeting, for the invitation to deliver them had been tentatively accepted for the previous year. They were given at the instance of the authorities of Johns Hopkins University, in the October following the Montreal meeting of the Association, at which Thomson presided over Section A (Mathematics and Physics), and a specially important discussion took place on the seat of the Voltaic electromotive force. The Baltimore lectures dealt with the wave theory of light, ' with the intention of accentuating its failures '—thus Thomson himself expressed their purpose, while fully recognising the fine qualities of the theory. Certainly, however, the occasion of the lectures gained in interest from the fact that it followed upon the meetings, not only of the British Association in Montreal, but also of the American Association for the Advancement of Science in Philadelphia. Thomson and other British representatives were present at the latter meeting, and from it a notable company proceeded to Baltimore to swell Thomson's audience. This included Rayleigh and a number of leading physicists, both American and British. ' I felt '—thus Thomson wrote in a later year—' that our meetings were to be *conferences of co-efficients,* in endeavours to advance science, rather than teachings of my comrades by myself.' The Baltimore lectures were the culmination of a wonder-year of scientific conference between physicists of the old world and the new.

Toronto, 1897

While the feeling against overseas meetings has never been entirely removed (for that could hardly be expected), the success of the Montreal meeting falsified any fears as to their effects on the well-being of the Association, and when an invitation was received for a meeting in Toronto in 1897, no serious obstacles were raised against its acceptance. It followed lines similar to those of the Montreal meeting: there were ample opportunities for intercourse between visiting members and Canadian and American men of science, and for scientific excursions. A special train was provided for a transcontinental journey of nine days' duration after the meeting. Kelvin, Evans, Rücker, and many other leading members took part in this excursion. Receptions were arranged at principal points along the line westward to Vancouver, and occasion was afforded to stop at points of scientific and scenic interest.

Among the scientific results of the meeting, reference is due to the impression made upon visiting members by the agricultural experimental stations established in Canada, and it was recommended that the Council should approach the home Government with a view to their imitation in Britain. While the Council, having regard to the widely divergent conditions of agriculture at home, did not find it desirable to carry out this proposal, it did urge upon the Board of Agriculture the desirability of co-ordinating existing institutions for agricultural research and strengthening the scientific work of the Board itself, and this recommendation was sympathetically received. A

tidal survey of Canadian waters had been started by the Canadian Government since the Montreal meeting: the Association at Toronto found this survey in danger of extinction, and urged against such a measure. The Council, on making a representation to this effect, learned that while the survey could not be extended at the time, the existing tidal gauges and the preparation of tables were to be maintained. A committee was formed, with a grant, under which a plant for meteorological observations was established on the summit of Mount Royal at Montreal. Another committee secured the establishment of a marine biological station in the Gulf of St. Lawrence; a third undertook the investigations of Canadian Pleistocene flora and fauna; the committee on the north-western tribes of the Dominion, appointed at the Montreal meeting, was still at work, and another, with the Toronto meeting in prospect, had been appointed in 1896 to take up an ethnological survey of Canada, and subsequently presented a series of reports.

South Africa, 1905

In 1905 the Annual Meeting was held in South Africa. A sum of £6000 was subscribed by the Governments of Cape Colony (£3000), Transvaal and Orange River Colony (£2000), and Natal (£1000), as a subvention toward the ocean passages of members of an official party of invited guests, and a South African Fund amounting to £3100 was privately subscribed in England to meet extraordinary expenditure in connexion with the meeting. The number of visiting members was 380. By a special

arrangement with the South African Association for the Advancement of Science, members of that body were enrolled as associates of the British Association. The programme of scientific work was on a more elaborate scale than had hitherto been attempted. The sections began their meetings at Cape Town, and continued them at Johannesburg. The Presidential Address (by Professor, afterwards Sir, George Darwin) was delivered in two parts, one in each of these two cities, and the sectional presidents' addresses were divided between them, that in Section L (Education) being delivered at both. A party which numbered 347 overseas visitors and 85 members resident in South Africa received free railway passes for the whole or parts of an extensive journey, for which special trains were provided by the Cape and Natal Governments. This journey embraced official visits to Durban, Pietermaritzburg, Colenso and Ladysmith, Johannesburg, Pretoria, Bloemfontein, Kimberley, Bulawayo, and the Victoria Falls of the Zambezi. At all these, excepting Colenso, Ladysmith, and the Victoria Falls, lectures were delivered by members. Lavish hospitality was extended to visitors: Gill humorously records the embarrassment of a lady member who found that 'a strange man' insisted upon paying for her hotel accommodation at one of the centres. At the Victoria Falls the railway bridge over the Zambezi was formally opened by the President, in the presence of Sir Charles Metcalfe and other officers of the British South Africa Company. A special series of postage stamps was issued to commemorate this event. The party, after returning to Bulawayo, divided, one portion proceeding by Salisbury, Umtali, Beira, and the east

coast route to England, while the other went home by Cape Town and the west coast.

In commemoration of the visit, a fund was raised among the members who made the journey, for the provision and endowment of a medal and scholarship or studentship for South African students. To the fund thus raised, amounting to £859, was added the balance (about £800) of the special fund referred to above. The medal was struck in bronze from a design by Mr. Frank Bowcher, and the symbolical figure on the reverse side of it has since served the Association as a badge, and appears on the title-page of this volume. The fund was placed in the hands of trustees (now the Superintendent-General of Education for the Cape Province, the Controller and Auditor-General for the Union of South Africa, and the Registrar of the University of South Africa), and the award in those of the South African Association for the Advancement of Science.

Following resolutions forwarded from the South African meeting the Council took action dealing with the completion of the geodetic arc from the south to the north of Africa, the establishment of a topographical survey, and the prosecution of a magnetic survey of South Africa ; also upon resolutions dealing with the collection of information concerning natives whose habits of life had not been affected by the advance of civilisation, with the nomenclature of groups of natives, and with instruction in comparative ethnology for officers administering native affairs. A grant of £300 from the South African Fund was made toward the completion of the connexion between the Rhodesian and Transvaal triangulations along 30° E. longitude. The co-operation of

the South African Association was invited in connexion with the resolutions concerning native characteristics and nomenclature. The same body, with the consent of the Council, prepared for publication, in four volumes, all the papers of South African interest read at the sectional meetings. Research committees were formed in connexion with the magnetic survey of South Africa, the correlation and age of South African geological strata, the study of the freshwater fishes of South Africa (especially those of the Zambezi), of South African cycads, and of the fossil flora of the Transvaal, and other researches less directly concerned with South Africa were taken up as results of the meeting. The special attention paid to geodetic and allied topics is sufficiently explained by the presence and inspiration of Sir David Gill, who also was primarily responsible for the arrangements made in South Africa for the meeting.

Winnipeg, 1909

After a short interval the Association again went abroad, meeting in Winnipeg, Canada, in 1909. It is of incidental interest to observe the westward progress of the successive Canadian meetings, in Montreal, Toronto, and Winnipeg: and to quote a few lines from Sir William Tilden's memoir of Sir William Ramsay (London, 1918), who was one of a party which before attending the Montreal meeting made an extended tour in the west: 'At Winnipeg they stepped off to see what remained of old Fort Garry, the great seat of the early days of the Hudson's Bay Company. Twenty[-five] years later the British

Association was to be royally entertained there, but at the time it was just in its infancy. The houses were mostly one- or two-storied buildings, standing back from "side-walks" made of rough planking, and the middle of the streets were virgin soil. There had been rainy weather, and the traffic had made deep ruts that were nearing danger point, and a great plough was going over them, followed by a thing like a harrow ploughing up the main streets and levelling them down. In a few years all was asphalte and order, with electric light and street cars, and old Fort Garry was a thing of the remote past.' Moreover, in 1909 the University of Manitoba was found to afford the Association accommodation for its offices and several of the sections. The Dominion Government contributed \$25,000 towards the expenses of the meeting, the province of Manitoba \$10,000, the city of Winnipeg \$7800, the provinces of Alberta, British Columbia, and Saskatchewan \$5000 each, and smaller grants by other public bodies made up a total contribution of about \$60,000. A sum of \$15,565 was contributed out of the local fund towards the travelling expenses of a selected party of the visiting members. The president, vice-presidents, and officers of the American Association for the Advancement of Science were invited to attend the meeting as honorary members, and fellows and members of that association were admitted on the same terms as old annual members. Visiting members of the British Association, who numbered 475, obtained, as before, special rates for the transatlantic passage and on a number of Canadian and American railways, and on the outward journey some of them availed themselves of facilities to visit Macdonald College,

near Montreal, McGill University, and other institutions, while a party of geologists was enabled to visit the centres of mining activity at Cobalt and Sudbury. The Winnipeg meeting followed the normal course of annual meetings, with the exception that in place of the then usual single lecture to artisans, two popular lectures to the citizens were provided; moreover, it was found possible to admit a limited number of the general public to the president's address and the evening discourses. After the meeting, a special train on the Canadian Pacific and Canadian Northern Railways was provided by the liberality of the western provinces of Saskatchewan, Alberta, and British Columbia, in which 200 invited guests were conveyed on a tour to the west, on lines similar to those of the excursion after the Toronto Meeting in 1897. From Vancouver the party went by steamer to Victoria, where it was received by the provincial Government, and on the return to Vancouver Sir William White gave a lecture on 'Naval Affairs.' On the return journey there was a reception at Edmonton and an excursion on the North Saskatchewan River.

Among the scientific results of the meeting was the appointment of a committee to investigate the flora of the prairie provinces. Another was appointed (in pursuit of investigations undertaken at earlier Canadian meetings) to further a scheme for an ethnographic survey of Canada, and the Council took action to the same end, which led to the establishment of a department of ethnology under the Geological Survey of the Dominion. Among the sectional transactions, reference is due to an appropriate and important discussion and papers on

wheat culture and agricultural development, which were printed in full in the report of the meeting. Following a suggestion made at the meeting, a list of desiderata for the library of the University of Manitoba was widely distributed among members of the Association and learned societies, by which means a substantial collection of books, journals, and reprints was made for the library.

Australia, 1914

In 1914 the annual meeting was held in Australia.[1] The possibility of such a meeting was discussed as early as 1884 (clearly in consequence of the interest aroused by the first overseas meeting at Montreal), but the time was not yet ripe. The question was raised again in 1909, when Sir Charles Lucas, head of the Dominions Department of the Colonial Office, was visiting Australia. The question was now taken up in earnest: the support of leaders of both principal parties in the Commonwealth Government was secured, and the promise of a grant from that Government toward the overseas expenses of the visit was obtained, together with similar promises from other authorities. In the event, the Commonwealth Government participated, through its High Commissioner in Great Britain, in proffering the invitation to the General Committee in 1910; it also granted £15,000 to cover passages of not fewer than 150 official representatives of the Association, 'including selected Dominion and foreign scientists.'

[1] A fuller official narrative exists of this meeting than of earlier overseas meetings: it is freely quoted in the following account. It appears in the *Report* for 1914, and was also separately printed.

This grant represented a substantial increase over that originally proposed, for the General Officers of the Association, judging (as events proved, rightly) that a representative body could be gathered together larger than that for which the sum originally proposed would have afforded sufficient provision, took advantage of the occasion of Their Majesties' Coronation, when members of the Commonwealth Government were present in London, to discuss this matter with them. The suggestions then made, from the point of view of the Association, were received in the most generous spirit by the representatives of the Commonwealth.

The General Committee accepted the invitation for the year 1914. Preliminary organisation in Australia was placed in the hands of a Federal Council or central executive, with executive officers and committees in each of the mainland States, and Dr. A. C. D. Rivett, of Melbourne University, was appointed organising secretary in Australia. For the Australian meeting had a more elaborate programme, in certain respects, than even the South African meeting, on which it was modelled; it was not confined to a single centre, but official business was carried out, as will be seen, at five widely separated centres, the State capitals of Perth, Adelaide, Melbourne, Sydney, and Brisbane. Besides its contribution of £15,000 for overseas travelling, the Commonwealth Government defrayed all the organising secretary's expenses and those connected with the work of the Federal Council. It also contributed largely to certain of the official entertainments during the meeting. The State Governments, besides undertaking the whole cost of visiting

members' railway travelling in Australia, by providing free passes and special trains over State railways, contributed each a large sum towards the general expenses of the local meeting. In each State local hospitality and excursion committees were formed. The principal steamship companies afforded special rates and other facilities for the overseas passages. It may be stated here that these other facilities included provision for research to be carried on during the voyage by some of the members, who were enabled to conduct marine biological investigations, observations on the force of gravity at sea, etc.

Inasmuch as participation in the meetings would involve an absence from home, in the case of members travelling from the British Isles, of at least three months, namely from July to September, the Council authorised the general secretaries to address a letter to universities and other educational institutions in the United Kingdom, requesting the authorities to do what lay in their power to relieve of examining and other duties, in July and September 1914, any members of their teaching staff who might contemplate attending the Australian meeting. The response to this request was favourable in the majority of cases, and very few instances came subsequently to the knowledge of the Association officers of members prohibited by professional duties from accepting invitations to attend the meeting. A letter in similar terms was sent independently by the Federal Council in Australia. Facilities were provided by the Federal Council for members who desired to prolong their stay in Australia in order to carry on special scientific work, and a considerable number took advantage of this arrangement.

The total number of the overseas visitors was 300, of whom 155 participated in the Commonwealth grant. These included 35 members and guests from British overseas dominions and from foreign countries. On the outbreak of war (which occurred, as will be seen, just as the general meetings were about to begin) some of the foreign guests became enemy subjects, and their position caused anxious consideration. All, however, were enabled to attend the meetings, though their return to their homes must in all cases have been rendered difficult, and was in certain instances delayed under military necessity.

The course of the meeting, briefly summarised, was as follows. An 'advance party' of about 70 overseas members reached Western Australia at or before the end of July and spent a week or more there before joining the 'main party' en route for Adelaide. At Perth, Western Australia, official lectures were given, and excursions took place. The whole overseas party (practically speaking) was united at Adelaide, South Australia, where, from August 8 to 12, two evening discourses and a citizens' lecture, and also two of the sectional presidents' addresses, were delivered. One of these last was given by Sir Charles Lucas as president of the Geographical Section: he, as we have seen, was a prime mover in the original proposal for the meeting. The other was the first portion of the agricultural address.

It was during the meeting in Adelaide that the first opportunity arose for any official consideration of the effect of the war on the meeting. As soon after their arrival as possible the majority of members of the Council present met 'in order to assure the Australian authorities of their acquiescence, on behalf of the

overseas party, in any modification of the programme which might be found desirable.' Representatives of the Federal Council and local executives replied that in their view the scientific and other business of the meeting should proceed, even if some of the social functions should have to be modified. This opinion was endorsed by a telegram of welcome received from the Governor-General (Sir R. Munro-Ferguson, afterwards Lord Novar). As events proved, modifications in the Australian programme were practically negligible, although (to anticipate the chronological order of this summary) the plans for the homeward journeys of many members had to be changed, owing to the requisitioning of vessels for military purposes; also, arrangements for an official visit to New Zealand by a small party were cancelled. A rumour or assumption that the entire Australian meeting was cancelled or collapsed became so firmly implanted in the minds of many persons who were not present, that it reappeared years later as a statement of fact in the Press and elsewhere.

At Melbourne, whither the party proceeded from Adelaide and stayed from August 13 to 19, the first part of the presidential address, two evening discourses, and two citizens' lectures were delivered. All the sections met, and sectional presidents' addresses were delivered in five of them. Exactly similar arrangements obtained in Sydney (August 20–26), where the second part of the presidential address was delivered. It had never been anticipated that all the overseas party would make the long journey to Brisbane after the close of the proceedings at Sydney, and some who had intended to do so were compelled by the altered shipping arrangements to return home

from there, but about two-thirds of the whole party proceeded to the Queensland capital, where the second part of the presidential address in the Agricultural Section, a departmental address on cosmical physics, a citizens' lecture, two ordinary evening discourses and two concluding discourses were delivered, bringing the whole meeting to a close.

It has been pointed out earlier in this chapter that it is impossible fully to assess the scientific results of any overseas meeting of the Association; and, for that matter, the same is true of any meeting at home. But there are more data for doing so in the case of the Australian meeting than others, and it is therefore pertinent to adapt to the uses of this record a substantial extract from the official narrative, in which a number of commentators give some indication of the scientific value and results of the meeting, apart from the transactions in the lecture-halls and section-rooms.

'Throughout the sessions in the various centres, in addition to the official meetings and excursions [these were numerous and admirably arranged with a view to scientific interests], special meetings, discussions and expeditions, informal as well as formal, were arranged by local men of science for particular groups in the overseas party. On such occasions (among which may be included the visits paid to university laboratories, museums, and other institutions by many of the party) problems for investigation were pointed out and plans for future research were suggested, of value to hosts and guests alike, and it is not improbable that some of these informal conferences may have as great a direct effect upon the advancement of science in Australia

as the more public meetings of the Association. As the Annual Report does not elsewhere offer any occasion to indicate the work done in these directions, a summary may be given here, with reference to the sections whose interests were specially concerned.' [Referring first to subjects associated with Section A, Mathematics and Physics], 'the Prime Minister of the Commonwealth (Mr. Cook) received a deputation of astronomers and physicists on the projected solar observatory on Mount Stromlo, and accorded them a favourable hearing. In Sydney the local branch of the British Astronomical Association requested, through the president, Dr. Roseby, a visit from the astronomers, some of whom attended and addressed the meeting. The Sydney branch of the Mathematical Association also invited some mathematicians to address them. The different State observatories (Perth, Adelaide, Melbourne, and Sydney), and Mr. Tebbutt's private observatory at Windsor, N.S.W., were all visited by several astronomers, and as a result of friendly discussion of problems and difficulties, invited by the directors of the observatories, several memoranda were drawn up by the visitors.

'The geologists of the party in Western Australia . . . visited the Irwin River to examine the Permo-Carboniferous glacial beds, marine beds and coal measures, the Darling Ranges to see the crush conglomerates of pre-Cambrian age, the Stirling Ranges with their highly contorted quartzites of unknown age, and finally the goldfields of Kalgoorlie and Coolgardie. At the time of the Adelaide meeting a party of geologists and chemists visited Port Pirie and Broken Hill for the purpose of seeing the occurrence of the ores and the methods of working

and smelting. Another party at the same time visited the Sturt River to see the Cambrian glacial beds, and explored the Permo-Carboniferous glacial beds and the archaeocyathine limestones of Hallett's Cove and finally the granitic rocks in the neighbourhood of Victor Harbour. From Melbourne the geologists went to Macedon to examine the alkaline igneous rocks and to Bacchus Marsh for the Permo-Carboniferous glacial tillites lying upon striated surfaces of older rocks. From Sydney there were excursions of both geological and biological interest to the Blue Mountains, which afforded the geologists an opportunity of studying the leading features of the geological structure of New South Wales and the remarkable elevation which this, in common with many other parts of the continent, experienced in late Tertiary or post-Tertiary times. An examination was also made of the Jenolan Caves, which are typical examples of stalactitic caves in limestone of Silurian age, one of the interesting features of which was the remains of an aboriginal skeleton embedded in the stalagmitic floor. The excursions to West Maitland and Newcastle gave an opportunity of examining the productive coal measures of the State. At Brisbane two of the most notable excursions arranged for geologists were those to the Glass House Mountains, a series of trachytic volcanic necks rising abruptly from the plain, and to Ipswich to examine the Trias-Jura coal measures and associated volcanic rocks. Some of the most noteworthy points that impressed the geologists from Europe were the remarkable extent on the Australian continent of Permo-Carboniferous glaciation, the evidence of comparatively recent extensive elevation, the well-preserved planes of erosion at different geological

horizons, and the evidences of glaciation as early as the Cambrian epoch.

'At each centre visited, the zoologists of the party were in close touch with the professor of the subject at the University and other local workers, and many of the excursions, both those in the official programme and others of a more informal character, were arranged so as to show the visiting specialists as much as possible of the Australian fauna. At Perth, in addition to the definitely zoological excursions to the Yallingup caves and to the Mundaring Weir . . . a few of the zoologists [visited] points of interest on the Darling Range, where *Peripatus* and other important organisms were found. From Adelaide parties of zoologists made observing and collecting trips to Lake Alexandrina, Victor Harbour on the coast, the Mount Lofty Range, and elsewhere, at all of which objects of interest were seen and much material collected which may lead to research. At Melbourne the local naturalists arranged several short trips in the neighbourhood to study the birds and the land fauna generally; while at Sydney the excursions were naturally rather of a marine biological character. . . . A collecting party in Port Jackson [explored] from a steam launch the wonderfully rich invertebrate fauna exposed at low tide in various parts of the harbour. From Sydney, again, the various excursions to the Blue Mountains and the Jenolan Caves gave zoologists the opportunity of collecting such rare and interesting forms as *Peripatus* and land Planarians and of seeing many of the characteristic birds and insects of the country; and the same may be said of some of the excursions from Brisbane. At the museums and University laboratories of Perth, Adelaide, Melbourne, Sydney,

and Brisbane informal discussions and conferences took place with the museum curators and other local naturalists, which led to the formation of research committees or to plans for future work on Australian problems. In connexion with the marine fauna, the question of more fully exploring the Australian fisheries was under consideration at several centres. Another outcome of informal conversations was the resolution [subsequently adopted] by the Council of the Association welcoming the project to convert a portion of Kangaroo Island in South Australia into a Government reserve for the protection of the fast-disappearing native land fauna.

'The facilities given to members of Section E (Geography) to study on the spot various types of land-forms in Australia were specially valued by those whose interests lie mainly in physical geography. Others had the opportunity of observing the influence of geographical factors, notably temperature and rainfall, upon the more important forms of economic activity in the country. The visit to Western Australia and the excursions to Yanco, Bendigo, and Gympie were of especial interest. Some members took advantage of their stay in the different capitals to make themselves acquainted with the literature relating to the discovery and early settlement of the continent. . . .

'Opportunities were given wherever possible to allow the anthropologists to see for themselves the aborigines and their craftsmanship. Thus, from Adelaide, . . . a party went to Milang on Lake Alexandrina to inspect a number of men, women, and children from the mission station, including some full-blooded aborigines. These gave displays of dancing, boomerang-throwing, hut-building, and

basket-making, and some of the party collected information in regard to cat's-cradle games and native genealogies. The anthropological collections in the museums at Melbourne, Sydney, Adelaide, Brisbane, and Perth were naturally of great interest, and under the guidance of the curators and other local anthropologists there were important discussions and critical examinations of specimens by experts, which will doubtless lead to further research. In the Melbourne Museum the magnificent collections of Australian stone implements, specially brought together for the occasion by Messrs. Kenyon and Mahony, as well as the ceremonial objects collected by Professor Spencer [Sir W. Baldwin Spencer], were on exhibition during the meeting, and were the subject of careful examination and discussion. Much of the more productive scientific work of the anthropologists naturally consisted in informal conferences with the local workers, and it was hoped that as one of the results of such consultations it might be possible to obtain from the Federal Government the assistance which is necessary for the prosecution of further research in the fast-disappearing cultural anthropology of the tribes in the Northern Territory.

'Field-work naturally played a large part in the botanical programme. At Perth an extended expedition to Albany, lasting for the greater part of a week, gave opportunities for studying the characteristic vegetation of the arid districts of Western Australia. From Adelaide there were three important excursions arranged specially for botanical work—one to study the Salicornia scrub and the mangrove swamps of the coastal region, one to the Mount Lofty Range to see the fern gullies and the scrub

of the higher levels, and the third to Mannum. The botanical excursions from Melbourne . . . included one to Emerald for the fern gullies . . . [and another] to inspect methods of orchard planting. Another party . . . was taken to Warburton to inspect a characteristic "big-tree" region and study the ecology of the district. From Sydney, in addition to the excursions to the Blue Mountains and to the Jenolan Caves district . . . there were a number of smaller informal excursions . . . to study the botany of the Port Jackson neighbourhood, including the National Park. Another party visited . . . the Bulli Pass and the Cataract Dam, passing through interesting country and a rich fern vegetation. Mr. J. H. Maiden[1] also conducted the botanists over the Sydney Botanic Gardens, and gave a special exposition of the herbarium. Of special botanic interest was the excursion from Brisbane to Nambour and the Blackall Ranges showing sugar-cane cultivation and many ferns, aerial orchids and other characteristic plants of the upland gullies.

'Before the regular work of the Association began, several members of the Agricultural Section took the opportunity of gaining some acquaintance with the special conditions of farming prevailing in Australia. The chief questions that occupied the attention of the section both in session and out of doors were dry-farming, irrigation, and the breeding of cereals. In South Australia dry-farming methods were receiving a searching test because of the prevailing drought. Notwithstanding, the wheat after fallow showed little signs of flagging, and impressed everyone by its brilliant green colour. Visits were

[1] Government botanist and director of the Botanic Gardens, Sydney.

paid to the Roseworthy Experimental Farm in South Australia, and the Werribee Farm in Victoria. . . . As regards irrigation, in addition to the discussion at Melbourne, the members of the section visited the small irrigation colonies on the lower Murray, the colonies at Bacchus Marsh and Werribee, near Melbourne, and the great Yanco settlement in New South Wales, where a meeting was also held and papers were read. On the subject of cereal-breeding a fruitful discussion took place in Sydney. . . . Dairying is an industry of great importance in Australia, and received considerable attention in the section. Some of the members of the section interested in this side of the work spent a large proportion of their available time amongst the dairying in the coastal districts of New South Wales and Queensland. . . . The problems of wool character and wool inheritance were raised both in the meetings and in the field, and though it will be long before a matter of so complex a character is brought under control, the question did receive some elucidation which may serve as a basis for future work. The members of the section owe a particular debt of thanks to the Agricultural Departments of the various States; in every case special arrangements were made for them, individually and collectively, so that each man had the opportunity of seeing the local work in which he was most interested.'

A number of unofficial lectures were given (in addition to those indicated above) by members of the overseas party at various places on the Australian mainland, and in Tasmania, which was visited by a party, principally of biologists, after the meeting. The overseas members gave some evidence of their

gratitude to the Commonwealth by the subscription of over £600 to the patriotic funds which were then being raised in consequence of the outbreak of war.

One reason for dealing with this more amply than other overseas meetings has been indicated above; another is that the preoccupations of the war deferred the full realisation of the after-effects of this particular meeting in the direction of research recommendations to Governments, and the like. Judged merely by the very large number of members who took part in it (see p. 117), joining in the various centres in Australia, the Australian meeting was by far the most successful the Association has ever held. But that is not the sole test, and there is no ground for asserting that any one overseas meeting has been more successful than the rest. They have all justified the action of those who, in 1881 and after, promoted the first of them, even though the breaks of continuity which are caused in the meetings at home be still regretted, and may yet seek for remedy in future.

A party of members unable to make the voyage to Australia in 1914 attended by invitation the meeting of L'Association Française pour l'Avancement des Sciences at Havre. The Conference of Delegates of Corresponding Societies also met there, and were enabled to participate in a discussion on the organisation of local scientific societies in France. Sir William Ramsay led the members' party. He gave an address in French which dealt, among other matters, with international amity. Within a week Europe was at war. The meeting had to be curtailed, and Ramsay and others were reluctantly obliged to leave France with such haste as was possible.

CHAPTER V

THE ASSOCIATION AND RESEARCH: KEW OBSERVATORY

Grants for research—Gifts to the Association—Initiation of research work—Foundation of Kew Observatory—The Observatory under the Association—Description of the Observatory, 1860—Later period of the Association's control—The National Physical Laboratory.

Grants for Research

In order to furnish an easy, though not a complete, view of the wide range of support accorded to scientific research by the Association, we give in Appendix I a classified list of all the investigations upon which, from 1834 (when the first grant was made) down to the close of the financial year 1920–1921, money has been expended by the Association. For convenience these investigations are classified, as nearly as may be, under the headings of the existing sections of the Association (with the exception of the recently established section of Psychology), although, of course, many of them belong to a period before the whole of these sections were in existence. And we have indicated that this list does not provide a complete view; it must be premised that the Association has lent its countenance to a vast additional amount of research upon which it has not expended money in the way of assistance toward the researches themselves; and, further, that the

sums set out in the Appendix do not (save in the few instances where it is so stated) include any expenditure upon printing the results of scientific investigations, whether by committees or by individuals, which occupy so large a proportion of the annual reports issued by the Association.

The totals of the grants assigned in the Appendix to the various sections work out as follows :

Section.	£	s.	d.
A. (Mathematics and Physics) ...	34,977	18	7
B. (Chemistry)	4,178	17	8
C. (Geology)	6,956	3	11
D. (Zoology), and K. (Botany), jointly	1,579	1	10
D. (Zoology)	12,093	15	5
E. (Geography)	3,695	13	4
F. (Economics)	1,322	4	3
G. (Engineering)	4,164	7	6
H. (Anthropology)	7,226	16	11
I. (Physiology)...	3,115	13	7
K. (Botany)	1,952	15	1
L. (Education)	538	18	6
M. (Agriculture)	5	0	0[1]

In addition to the above, some few grants have been made which are incapable of classification under the headings of sections, and are scarcely, indeed, to be regarded as applied (at least directly) to research. These are the grants, amounting to £174 2*s.*, which were made toward the translation of foreign scientific memoirs, physical and biological, in 1840–41; the grants toward the publication of 'Science Abstracts,'

[1] It may be observed that the single subject and small sum classifiable under the heading of Agriculture are to be at least partly accounted for by the fact that agriculture was not made the subject of a separate Section until 1912, by which time research in agriculture was provided for from other sources.

£100, in 1899; the grants to the Corresponding Societies Committee (p. 94), amounting to £753 14*s.* 1*d.*, since 1889; and grants of £10 made to the newly established Conjoint Board of Scientific Societies in each of the years 1920 and 1921. These miscellaneous grants make a total of £1047 16*s.* 1*d.*

The above statement shows a total expenditure upon grants, from 1834 to 1921, of £82,855 2*s.* 8*d.* Great care has always been exercised upon the allocation of money for scientific investigations—and, indeed, upon the approval of any investigation, whether with a grant or not, proposed to be undertaken under the ægis of the Association. Any such proposals have to pass under the consideration of (i) the appropriate sectional committee, (ii) a Committee of Recommendations formed of representatives of all the sections and certain *ex-officio* members, and (iii) the General Committee, or, alternatively, the Council. A total sum of less than £83,000, spread over a term of eighty-six years, is not, truly, an imposing figure when applied to investigations in every department of science, and on more than one occasion a derisory picture has been drawn, by critics of the Association, of the best scientific brains in the country occupied in wrangling—the allocation, it must be admitted, has occasionally been accompanied by a process which may be thus described—over the yearly distribution of a paltry thousand pounds. The criticism is ungenerous. The British Association was not established as a society for the accumulation of funds for scientific objects, nor has it ever adopted (though it might have done and may yet do so) any systematic method of accumulating funds save through the subscriptions of members to whom it offers, as *quae*

pro quo, attendance at its annual meetings, and its published transactions.

Gifts to the Association

Few specific gifts for research have been made to the Association. In 1903 Sir Frederick Bramwell made a gift of £50, which was placed in 2½ per cent. self-cumulating consolidated stock, to be devoted in 1931 (*i.e.* at the centenary of the Association) to paying 'an honorarium to a gentleman to be selected by the Council to prepare a paper . . . dealing with the whole question of the prime movers of 1931, and especially with the then relation between steam engines and internal combustion engines.' Bramwell had himself, at the York meeting in 1881, shown noteworthy prescience of 'a change in the production of power from fuel. However much,' he said, 'the mechanical section of the British Association may to-day contemplate with regret even the mere distant prospect of the steam engine becoming a thing of the past, I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum.'

Bramwell's is an instance of a gift for the purpose of a specific investigation: it was not until 1912 that the efforts of the Association towards the general support of research received, unsolicited, their first endowment. This took the form of a cheque for £10,000, which was handed to the General Treasurer at the Dundee meeting in that year by Sir James Caird, free of condition. This sum was funded, and the income placed at the disposal of the Council for

application to the purposes of research. In 1913 Caird made a further gift of £1,000 for the purpose of investigations in radioactivity. In 1919, at the Bournemouth meeting, a fund was initiated by Sir Charles Parsons, then President, for the main purpose of enabling the Association temporarily to maintain its grants, during a period when research was with difficulty readjusting itself to peaceful channels after the years in which the war had in great measure diverted it from them, and the Association, through the intermission of its annual meetings for two years (1917–18), and for other obvious reasons throughout the period of stress, found its ordinary inflow of income seriously diminished.[1]

Initiation of Research Work

By our founders, wisely, no hint was given in 1831 of any possibility of subsidising research; but within three years of the foundation it appeared that a credit balance would emerge from the annual working, and it was immediately decided that research should benefit. 'Resolved, on the motion of Mr. Harcourt'—thus runs a minute of the General Committee dated 'Cambridge, June 1833'—'that the sectional committees be requested to select from time to time those points of science which on a review of the former recommendations of the committees or those contained in the reports published by the Association, or from suggestions made at the present meeting, they may respectively think most fit to be advanced by an application of the funds

[1] This book was about to go to press when Sir Charles Parsons added to his benefaction a gift of £10,000 War Stock (April 1922).

of the society either in compensation of labour or in defraying the expense of apparatus or otherwise. It is recommended to the committees to confine their selection to definite as well as important points, and where they may think proper, to designate individuals to undertake the investigation of such points and to state their reasons for the selection.'

It is probably true to say that fully one-half of the total receipts for membership tickets for annual meetings has been devoted to scientific investigations by way of grants[1]: members may therefore feel that by attending meetings they have advanced science in at least equal measure as they have improved their own minds. It is true that the sum of £83,000 distributed in aid of research on over six hundred subjects does not connote large subsidies as a rule, and indeed many of the subjects in the list of grants have only trifling sums set against them—payment for postage and stationery, perhaps, or for a few cheap materials. It is true, also, that the grants made by the Association are not uncommonly supplemented from other sources, provided that a research committee obtains the leave of the Association for such a course. But when this is said, the tale of researches undertaken under the guidance of the Association—whether with subsidies or without—should be regarded (by the layman) as an astounding monument to the devotion of seekers after scientific knowledge without material recompense. It is appropriate here to cite the opinion of one of our most famous presidents as to the value

[1] There is no record of receipts for tickets for annual meetings down to 1847. But from 1848 to 1920 a total sum of £145,132 10*s.* was received on account of tickets, and during that period £79,750 was expended on grants.

of the co-operation in research afforded by the Association. Kelvin's biographer records how 'his assiduous attendance at meetings of the British Association stimulated younger men into combined effort. He secured their service on committees, suggested often by himself, to investigate different subjects.'[1] Of the value of the work of such committees there could be no better judge, for from 1860 onward he himself served on forty-one of them.

It is further to be observed that the Association has never avowedly taken upon itself the burden of any grant which might be expected to become permanent. Grants made by the Association have been made rather with the object of setting on foot some new movement in scientific investigation, which, if justified by initial results and likely to require financial support of a permanent character, might seek such support, with the backing of the Association, from public or other sources better able to meet its needs. Even the expenditure of more than £12,000, over a term of thirty years, on the Kew Observatory was actually, as we shall presently see, a piece of pioneer work which led on to the establishment of one of the most important scientific foundations in the world. In regard to not a few other scientific developments of its period, the Association is in the position of a parent whose share of responsibility for the success of his offspring in later life is not always assessed at full worth.

It may well be that in future the Association will contribute less than before in pounds, shillings, and pence to the direct support of research. The value of money has changed so far that the balance at the

[1] Silvanus Thompson, *Life of Lord Kelvin*, vol. ii., p. 1127.

disposal of the Association for such a purpose is at the best not likely to increase, unless from sources not yet visible. Moreover, it is likely that any such balance might be more profitably employed through other means for the advancement of science, having in view the fact that a proportion of public funds, and a special department of the public administration, are now devoted to the maintenance of scientific investigation. Nevertheless, the Association, possessing a wider range of scientific interest than any other body of equal influence, ought always to maintain its powers of leadership and guidance in the direction of research.

Within the compass of a few pages it is impossible to discuss the value of even a tithe of the investigations to which the Association has lent its name and support, but in the following paragraphs and Chapter VI it is proposed to cite a few examples in illustration of this department of the work of our body. We begin with some notes upon that item in the list (Appendix I) against which stands by far the largest single sum—'Kew Observatory, 1843–72 . . . . £12,300 1*s.* 1*d.*'

Foundation of Kew Observatory

The site on which Kew Observatory now stands is identical with or close to that of a Carthusian priory of Jesus of Bethlehem. A Fellow of the Royal Society, Samuel Molyneux, came into possession of Kew House (which was demolished in 1803) by marriage with a grand-niece of Lord Capel, and in 1725 constructed and set up in it a telescope, which he used for observations which, continued after his

death by Bradley, resulted in the demonstration of the aberration of light. Frederick, Prince of Wales, son of George II, leased the house from Molyneux, and subsequently the Princess of Wales, mother of George III, resided there, and the observatory became disused. The fact that, as matters stood, the transit of Venus in 1769 could not be observed from Kew was brought to the notice of the King, who thereupon caused the observatory in the Old Deer Park to be erected from the designs of Sir William Chambers. The first superintendent was Stephen Demainbray the elder, who made the observations on the transit from the new observatory, and held his post until his death in 1782. The King was often at the observatory, and took much interest in its equipment, not only with instruments, but with models and natural history and mineralogical collections, so that the institution bade fair at one time to become one for general scientific purposes. This promise, no doubt fortunately, was not realised; but George IV and William IV maintained the Crown's interest in the establishment, and several members of the Royal Family attended lectures on various branches of physics there. The elder Demainbray was succeeded by his son Stephen, who was assisted by his nephew S. P. Rigaud, the Savilian Professor of Astronomy at Oxford.

The Observatory under the Association

In 1841 the Government decided no longer to maintain the observatory and museum at Kew. Demainbray's post had become a sinecure, and he was pensioned. The contents were distributed to

the British Museum, King's College, London, the College of Surgeons, and Armagh Observatory, and among certain members of the Royal Family. The Royal Society decided to apply for the building, and it was made over to that Society, but on subsequent consideration the Council reversed its previous decision. 'The building having thus become again unappropriated, a number of fellows of the Royal Society and members of the British Association, desirous that it should be retained for the purposes of science, recommended that an application should be made for it in the name of the British Association, and entered into a subscription for the purpose of promoting'[1] objects which they proceeded to state at length. The Marquis of Northampton and Lord Francis Egerton, as presidents respectively of the Royal Society and the British Association, and, among others, the names of Herschel, Lubbock, De la Beche, Rennie, Sabine, Buckland, Wheatstone, Murchison, and Gassiot appear among the subscribers. The objects detailed in the recommendation may be summarised as concerned principally with the verification and trial of old and new patterns of magnetic and meteorological instruments of all sorts, the observatory offering a favourable site for such purposes and for those of instruction in the use of instruments, and of occasional observations.

In March 1842 Murchison stated in the Council that 'there was reason to believe that, on a proper application being made, Her Majesty the Queen might be graciously pleased to place at the disposal of the British Association, to be used for scientific purposes,

[1] Historical Remarks by Sir Charles Wheatstone, in *Minutes* of Brit. Assoc. Council, December 11, 1869.

the building in Richmond Park formerly occupied as a royal observatory, but recently dismantled.' It was clearly urgent, if the building was to be saved for any scientific purpose, that prompt action should be taken. The Council took such action—or directed the President and General Secretaries, Whewell, Murchison, and Sabine, to do so—with a commendable decision which did not even wait for an estimate of the annual cost to the Association. This was in March: in the following May the building was handed over to the trustees; and at the ensuing annual meeting the Council, in its report to the General Committee, pointed out 'the facilities which [the observatory] would afford for the prosecution of experimental inquiries in the physical sciences, for which its locality is peculiarly suitable, as a place of reception for instruments and apparatus . . . and as a depository for the books or other property of the Association.' The Council hoped that its action would 'meet with the approbation of the General Committee,' which it did; and the Committee caused to be conveyed to Queen Victoria 'the dutiful and grateful thanks of the British Association for Her Majesty's gracious patronage and encouragement of science.' The sum of £183 4*s.* 7*d.* was spent by the Association during the year 1842–43 on the observatory—the first disbursement out of a total of £12,300 down to 1872, to which reference has been made already. A committee was formed to supervise the arrangements at the observatory: relying on the help of some of the members of the Association in 'keeping the monthly meteorological terms,' they furnished a bedroom there for £15. This is a single instance of

economy in administration which, while compulsory in view of the limited resources of the Association, is nevertheless to be admired. The first officer in charge of the observatory under the Association, who kept a regular meteorological register, received apartments, fuel, and light, and a salary of £27 7*s*. 6*d*. per annum. He acted under the superintendence of Professor Wheatstone, who during the first year established (1) an ordinary meteorological record with standard instruments, (2) a meteorological record with 'self-registering instruments on a new construction,' (3) a record of the electrical state of the atmosphere, with an apparatus purchased by private subscription.

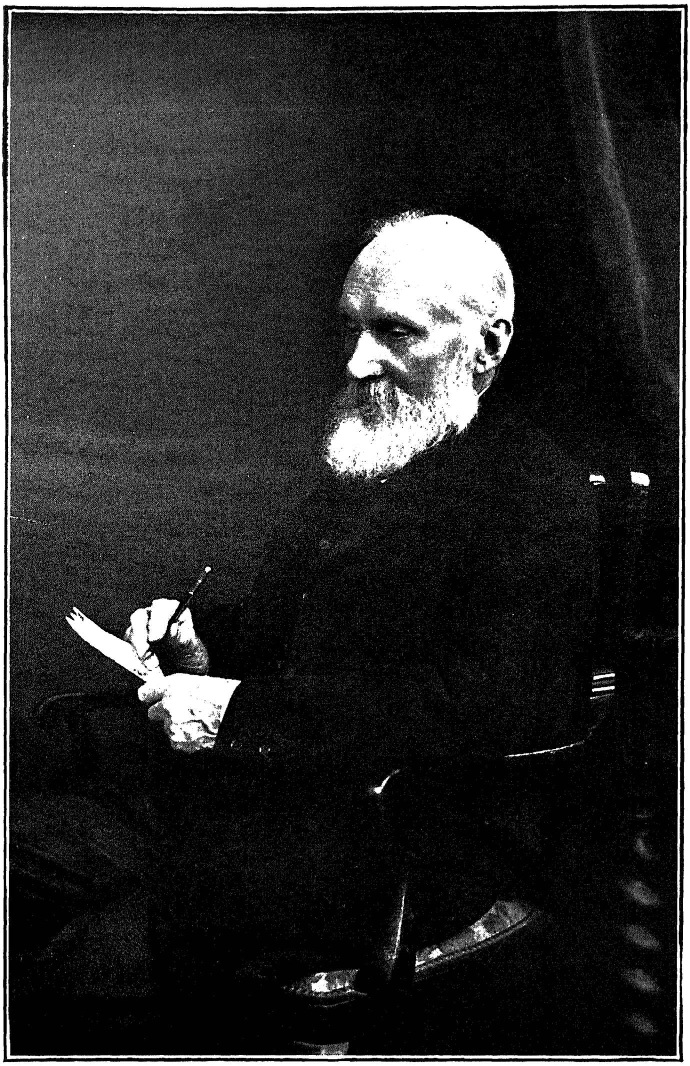
As early as 1845 the Council was asked by the General Committee to consider the expediency of discontinuing the observatory. From the earliest years it had been held that the Association, as stated in a preceding paragraph, should not, unless in exceptional circumstances, charge itself with the permanent maintenance of any particular research work or institution. At this period the interests of meteorology, astronomy, terrestrial magnetism, and allied departments of science were very strongly represented in the Association by John Herschel, Sabine, and others, and a series of resolutions was addressed to the Government and other bodies as an outcome of the 'magnetic conference' at the Cambridge meeting (1845), asking for the continuance or establishment of magnetic and meteorological observations at Greenwich, Dublin, Toronto, St. Helena, the Cape of Good Hope, Bombay, and Madras, and in Tasmania and elsewhere, and proffering advice as to the maintenance of such work; some of which recom-

mendations at least had important results. As for Kew, the observatory, now under the honorary superintendence of Francis Ronalds, emerged with credit from an investigation by a committee of the Council, which reported in favour of its maintenance because it afforded a 'local habitation' to the Association and opportunity for members to carry out physical inquiries, was already attracting the attention of foreign scientific men, and was proving its worth, among other directions, in that of forming a testing-house for instruments, while 'a systematic inquiry into the intricate subject of atmospheric electricity' had 'in effect furnished the model of the processes conducted at the Royal Observatory.' The possibility of obtaining Government support for the institution, or of handing it over as a going concern, continued to occupy the attention of the Committee and the Council, but the time was not ripe, and as the work developed the Association was even compelled largely to increase its annual grants to the observatory. Nevertheless, the general policy already defined in regard to grants of money by the Association was maintained in regard to the functions of the observatory: thus, it is described in the report of 1850 as 'an experimental observatory, devoted to open out new physical inquiries, and to make trial of new modes of inquiry, but only in a few selected cases to preserve continuous records of passing phænomena.' In this year the Royal Society allotted £100, out of the Government grant, for new instruments to be tried at Kew, and, as will be seen, subsequently devoted considerable sums to the observatory, at intervals down to the point when it was taken over by the Society in 1872. The construction

and verification of standard meteorological and magnetic instruments was 'one of the great objects' of the observatory. The standard thermometer was perhaps the most noteworthy example. The Committee reports in 1851:

'The standard thermometer, which M. Regnault kindly undertook to supply, has been received at the observatory, together with apparatus for verifying the freezing- and boiling-points. This verification has been made under the superintendence of a sub-committee, consisting of Mr. Gassiot, Dr. Miller, and Colonel Sabine, with most satisfactory results. . . . The Committee is able to report that the observatory may now be considered to possess a standard thermometer, with which other thermometers designed to be used as standards may be advantageously compared.'

John Welsh became superintendent of the observatory in 1852, and from then until his death in 1859 he substantially extended its various activities. The verification of thermometers, barometers, and other instruments developed into a considerable business: in the period 1854–69 over 11,000 thermometers, nearly 2000 barometers, and nearly 2500 hydrometers were verified, and a limited number of the standard thermometers were actually constructed at the observatory. Many other instruments, principally magnetic, were verified, and in many instances instruction in their use was given. The observatory thus assisted in the equipment not only of Government departments at home, together with numerous private establishments, but also of institutions and individuals in many parts of the world,



KELVIN

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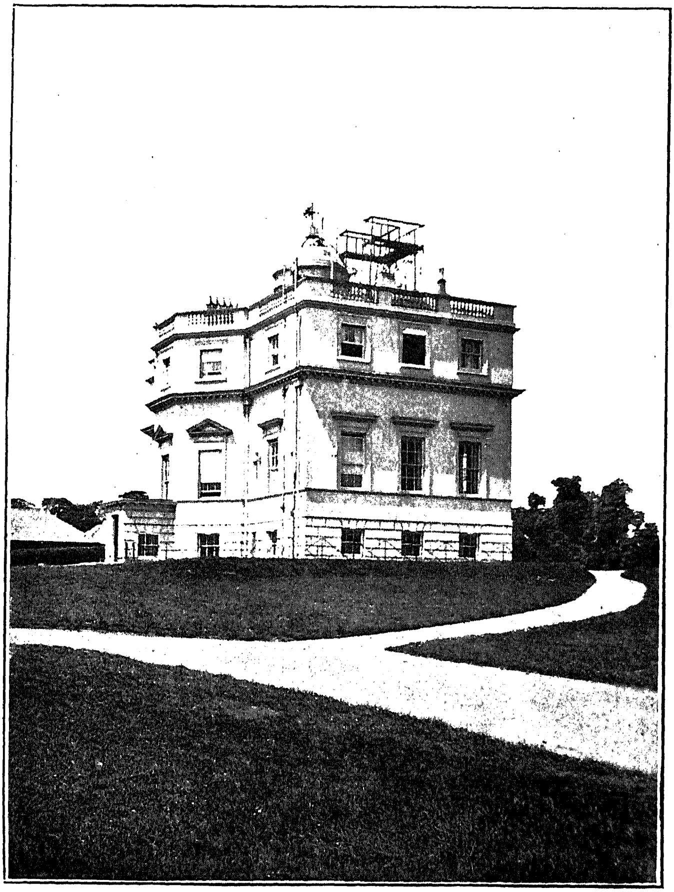

KEW OBSERVATORY

At the present day. The upper storey has been altered since the Association's tenancy.

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such as the East India Company, the Indian Trigonometrical Survey, H.M. observatory at the Cape, observatories in Java and at Melbourne, Hobart, Madrid, Lisbon, Kronstadt and elsewhere, the Smithsonian Institution, etc. Instruction was given to members of Livingstone's African expeditions, to officers of the Oregon Boundary Commission, and in other such cases.

The investigation of the upper atmosphere (a subject in which, through a research committee, the Association has maintained its interest in recent years) appears as a function of the observatory organisation in 1852, when the Council requested the Kew Committee 'to communicate with parties ascending in balloons, and to arrange, when practicable, for the accurate observation of meteorological phænomena in the ascents.' Following upon this request, the committee 'put itself into communication with the veteran aeronaut, Mr. Green, and arranged for four ascents with his great Nassau balloon.' The prime objects of investigation were the laws of 'decrement of temperature and of aqueous vapour in ascending in the atmosphere.' The balloon carried a double set of instruments, constructed under the superintendence of Welsh, and including syphon barometers, dry- and wet-bulb thermometers, and hygrometers. The first ascent at least was an occasion of some notoriety: it took place (as a matter of history) from the famous Vauxhall Gardens, on August 17, 1852; members of the Councils of the Association and the Royal Society and other men of science were 'invited to assist,' and a number of meteorologists in various parts of the British Isles collaborated, during this

and subsequent ascents, by taking hourly observations of their instruments while the ascents were in progress, in order to provide a mass of comparative data. Elevations of 19,474 ft., 19,140 ft., 12,652 ft., and 22,940 ft., were reached during the four ascents respectively, and the results were of substantial value as a pioneering investigation. Contributions towards the expenses of the ascents were made by the Royal Society from the Wollaston Fund, and by J. P. Gassiot, whose interest in the observatory throughout the period of the Association's tenure was continually active and practical. The results of the investigations were communicated to the Royal Society by Welsh, and printed in the *Philosophical Transactions*.

In 1855 it was reported that the Government desired that magnetic and meteorological instruments, showing the high standard they had reached in this country, thanks largely to the work of the observatory, should be exhibited at the Universal Exhibition in Paris, and an exhibit of thirty-four instruments, groups of instruments, and records was accordingly sent.

Description of the Observatory, 1860

A description of the famous little building as it was in 1860, from the report of that year, is not without interest.

'The observatory is situated in the middle of the old Deerpark, Richmond, Surrey, and is about three-quarters of a mile from the Richmond railway station. Its longitude is 0° 18′ 47″ W., and its latitude is 51° 28′ 6″ N. It is built north and

south. The repose produced by its complete isolation is eminently favourable to scientific research. In one of the lower rooms a set of self-recording magnetographs, described in the Report of the last meeting of the Association, is constantly at work. These instruments, by the aid of photography, furnish a continuous record of the changes which take place in the three magnetic elements, viz. the declination, the horizontal force, and the vertical force. The light used is that of gas, in order to obtain which, pipes have been carried across the Park to the Observatory, at an expense of £250, which sum was generously defrayed by a grant from the Royal Society.

'Attached to this room is another, of a smaller size, in which the necessary photographic operations connected with magnetography are conducted.

'In the storey above the basement, the room by which the visitor enters the observatory is filled with apparatus. Much of this is the property of the Royal Society, and some of the instruments possess a historical value; for instance, the air-pump used by Boyle and the convertible pendulum designed by Captain Kater, and employed by him, and subsequently by General Sabine, in determining the length of the pendulum vibrating seconds.

'An inner room, which opens from this one, is used as a library and sitting-room, and in it the calculations connected with the work of the observatory are performed. In this room dipping-needles and magnets, which it is necessary to preserve from rust, are stored. Here also the MS. of the British Association Catalogue of Stars is preserved.

'A room to the east of this contains the standard barometers, and the apparatus (described by

Mr. Welsh in the *Transactions* of the Royal Society, vol. 146, p. 507) for verifying and comparing marine barometers with the standard. This room has also accommodation for the marine barometers sent for verification. In the middle of the room is a solid block of masonry, extending through the floor to the ground below. To this an astronomical quadrant was formerly attached; it is now used as a support for the standard barometers. This room contains also a photographic barograph invented by Mr. Francis Ronalds, which, though not at present in operation, may serve as a model for anyone who wishes to have an instrument of this description. It is described by Mr. Ronalds in the Report of the British Association for 1851.

'In a room to the west of the library, thermometers for the Board of Trade, the Admiralty, and opticians, are compared with a standard thermometer by means of a very simple apparatus devised by the late Mr. Welsh.

'The observatory also possesses a dividing-engine by Perreaux, by means of which standard thermometers are graduated. It was purchased by a grant from the Royal Society.

'In this room the pure water required for photographic processes is obtained by distillation; and here also a small transit telescope is placed for ascertaining time. The transit instrument is erected in a line between two meridian marks—one to the north and the other to the south of the observatory; so that, by means of suitable openings, either of these marks may be viewed by the telescope.

'In the higher storey is the workshop, containing, among other things, a slide-lathe by Whitworth, and a planing machine by Armstead, both of which were

presented to the Kew Observatory by the Royal Society.

'In the dome is placed the photoheliograph for obtaining pictures of the sun's disk; attached to the dome there is a small chamber in which the photographic processes connected with the photoheliograph are conducted. This chamber is supplied with water by means of a force-pump. A self-recording Robinson's anemometer is also attached to the dome.

'In addition to the rooms now specified, there are the private apartments attached to the observatory.

'On the north side of the observatory there is an apparatus similar to that used at the Toronto Observatory for containing the wet- and dry-bulb, the maximum and the minimum thermometers.

'The model magnetic house . . . stands at a distance of about 60 yards from the observatory; and the small wooden house in which the absolute magnetic observations are made, at a distance of about 110 yards. These houses are within a wooden paling, which fences them off from the remainder of the park, and encloses about one acre of ground attached to the observatory.

'The work may now be briefly specified. In the first place, the self-recording magnetographs, as already mentioned, are kept in constant operation, and record the changes continually occurring in the magnetic elements.

'The photographs are sent to General Sabine's establishment at Woolwich, to undergo the processes of measurement and tabulation. . . .

'In the house for absolute determinations, monthly values of the declination, dip, and horizontal magnetic force are taken, and magnetic instruments

for foreign or colonial observatories have their constants determined.

'In the meteorological department, all the barometers, thermometers, and hydrometers required by the Board of Trade and the Admiralty have their corrections determined; besides which, similar instruments are verified for opticians. Standard thermometers also are graduated, and daily meteorological observations are made, an abstract of which is published in the *Illustrated London News*.

'Instruction is also given in the use of instruments to officers in the army or navy, or other scientific men who obtain permission from the Committee.'

Later Period of the Association's Control

This is not the place to attempt even a summary of the many pieces of individual research which were undertaken at Kew under the Association: reports upon them, and upon the work of the observatory generally, were communicated from time to time at the annual meetings of the Association and are printed in the annual volumes. It may be remarked, however, that the report of 1864–65 shows that 'Kew is the first public institution which has taken up the subject of sunspots,' and this statement leads to the announcement that Hofrat S. H. Schwabe of Dessau had 'placed his valuable and extensive series of sun-pictures at the disposal of the Royal Astronomical Society for the immediate use of the Observatory.' Reference is also due to the relations between the Meteorological Department of the Board of Trade, the Superintending Meteorological Committee nominated by the Council of the Royal Society in 1866, and the observatory. The secretary of the Committee

was Balfour Stewart, who was already superintendent of the observatory, which was to become the central observatory for a series of others (Falmouth, Stonyhurst, Glasgow, Aberdeen, Armagh, Valencia) 'provided with similar self-recording instruments, and distributed throughout the country in such a manner that by their means the progress of meteorological phenomena over the British Isles might be recorded with great exactness.' From this time (1867) onward the work at the observatory is considered under two headings: (*a*) that done under the direction of the Association; (*b*) that done at Kew as the Central Observatory of the Meteorological Committee. In addition to what may be termed the external services of the observatory, the report of 1869 points out 'that the system of automatic records established and in actual work at the Kew Observatory comprehends magnetic, barometric, and thermometric observations, as well as those of the direction and velocity of the wind.'

The way was at last becoming clear for relieving the Association of a burden such as it was not designed to support, though we have seen that in supporting it, it filled a breach which might otherwise have grown beyond repair. In 1869 the Council resolved 'that the present relations between Kew Observatory and the British Association be continued unaltered until the completion, in 1872, of the magnetic and solar decennial period; and after that date all connexion between them should cease.' In 1871 the Council of the Royal Society intimated readiness to take possession of the observatory, which in the following year duly passed under the control of that body.

The National Physical Laboratory

The Association participated actively in the movement for the establishment of a National Physical Laboratory, as will appear again in Chapter VII. Not only so, but the original suggestion for its foundation may be traced to the address to Section A (Mathematics and Physics) by Professor [Sir] Oliver Lodge at Cardiff in 1891, when he took occasion 'to call attention to the fact that the further progress of physical science in the somewhat haphazard and amateur fashion in which it has been hitherto pursued in this country is becoming increasingly difficult, and that the quantitative portion especially should be undertaken in a permanent and publicly-supported physical laboratory on a large scale.' Sir Douglas Galton, in his presidential address at the Ipswich meeting in 1895, pressed the same view, contrasting unfavourably to this country the support afforded by the State to science here and abroad, especially in Germany. In 1897 followed the appointment, by H.M. Treasury, of a committee under the chairmanship of the late Lord Rayleigh, to consider the project. The committee recommended in favour of the idea, and proposed the extension of Kew Observatory to meet the requirements of the laboratory. A working scheme was drawn up and put into effect in 1899, and the observatory was at first made use of, but the suggested extension was found impracticable, and in the following year Bushy House, Teddington, was placed at the disposal of the laboratory by the Crown. Here were established the departments of physics and engineering, while the observatory continued in use, housing the observatory depart-

ments, until 1910. It ceased, however, before that year, to be suitable for magnetic work, owing to the disturbance caused by electric railways in the vicinity, and for this purpose the new magnetic observatory at Eskdalemuir, Dumfriesshire, took its place. Meteorological research work continued at Kew, and in 1910 the control both of this and of the Eskdalemuir observatories passed to the Director of the Meteorological Office. The testing of thermometers, watches, and other instruments, however, continued at Kew as it had under the Association's regime until 1913, when this work was transferred to Bushy House. But Kew Observatory still carries on its meteorological work, rescued from extinction by the British Association, whose action and expenditure during those thirty years, 1842–72, not merely ensured for the future the maintenance of an institution of prime interest in the history of scientific research, but also led in direct line of succession to the establishment of a most powerful instrument for the advancement of science in the service of the State. The establishment of the National Physical Laboratory was an important achievement by Science in the education of the Government and the public, and the use of the British Association as a mouthpiece has never been more clearly demonstrated.

CHAPTER VI

SOME BRITISH ASSOCIATION RESEARCHES[1]

Astronomy—Seismology: Subterranean temperatures—Tides and waves—Meteorology and Climatology—Terrestrial magnetism—The sea-level—Electrical standards—Chemical researches—Geology in the Association—Zoology and Botany: Exploration—Anthropology—Physiology—Economics—Educational problems—Engineering and allied researches.

Astronomy

THE outstanding work of the Association in the department of astronomy is the preparation of the British Association Catalogue of Stars. This was the principal of a series of collateral undertakings set on foot in 1839, and including the reduction of Lacaille's stars and that in the *Histoire Céleste*, and for the revision of the nomenclature of the stars. Baily, Airy, Robinson, Herschel, Henderson, and Whewell were the prime movers in the matter, the first three having charge of the catalogue at the outset. It aimed at being a complete compendium of all star places of any accuracy down to the date of its issue, and its value is demonstrated by the fact that though it is

[1] In selecting for remark a few of the investigations which have been carried out under the auspices of the Association, the compiler gratefully acknowledges the advice and assistance of Prof. H. E. Armstrong, Sir Edward Brabrook, Sir Horace Darwin, Mr. W. F. Denning, Mr. W. H. Dines, Dr. A. R. Dwerryhouse, Sir Archibald Geikie, Sir Richard Glazebrook, Sir William Herdman, Prof. H. Lamb, Dr. H. R. Mill, Hon. Sir Charles Parsons, Prof. E. B. Poulton, Dr. J. Proudman, Sir Edward Schafer, Prof. A. Smithells, Mr. A. G. Tansley, Prof. H. H. Turner.

over seventy years old as a publication, and though astronomy has enormously advanced since its appearance, it is still the only work of its kind, and copies command a high price. Attempts have been made to construct compendiums, but at the best with only partial success. It is a notable instance of the catholicity of the Association that so considerable an expenditure should have been devoted to a work of this kind, which is an essential part of the technical equipment of one particular science. The Royal Astronomical Society, which appropriately produced an earlier volume, lacked the funds to proceed to the next much needed step, but the Association was able to come to the rescue of the scheme.

In regard to the investigation of luminous meteors and aerolites, annual reports on the progress of meteoric astronomy were published between 1848 and 1880; and under the direction in earlier years of Baden Powell, and later of Alexander S. Herschel, a mass of observational facts and allusions to contemporary investigations concerning meteors was published in the Association reports and formed an almost exhaustive means of reference and basis for critical study. The position of meteoric astronomy during the years above mentioned may be said to have changed entirely, for our knowledge of both its theoretical and practical sides stood in a very crude and imperfect condition in 1848, while in 1880, when the labours of the Association committee on luminous meteors ceased, this branch had been so much advanced as to be considered a very important section of astronomy. Schiaparelli, Newton, Adams, and others made investigations which led to the discovery of an intimate connexion, if not absolute

identity, between comets and meteors, and the work of the Association committee contributed to this achievement in no small degree. The real paths of meteors were very accurately computed by A. S. Herschel, and he, in collaboration with R. P. Greg, determined a considerable number of radiant points which were tabulated and formed into catalogues convenient for the guidance of future workers. Even to-day, over forty years after the publication of the final meteoric report by the Association, much of the data collected and printed in the annual volumes is of great interest to students and possesses an enduring value. Apart from the actual importance of the work accomplished by the committee, a large measure of interest was attracted to this department of astronomy.[1]

The measurement of lunar disturbance of gravity in 1879–81 received only modest financial assistance from the Association, but 'the recognition of the British Association,' writes Sir Horace Darwin, 'was even more important, and in my opinion little or nothing would have been done without this British Association committee.' An instrument, slightly modifying one suggested by Kelvin, was set up in the Cavendish Laboratory, and detected very small alterations in the direction of gravity with reference to itself. The additional conclusion was arrived at that 'the instrument was always moving relatively to the earth by an amount greater than the expected movement due to the moon, and this was due to slight earthquakes always going on.'

[1] Mr. W. F. Denning.

Seismology: Subterranean Temperatures

The support which the Association has for so long afforded to the study of seismology was indissolubly connected down to 1913 with the name of John Milne (1850–1913). Two committees, the one for studying earth tremors generally, and the other for investigating the earthquake and volcanic phenomena of Japan, were used in 1895, with their respective secretaries, C. Davison and Milne, as joint secretaries of the new committee. Milne, whose life interest was formed by his experience of Japanese earthquakes in 1876 and following years, and his desire, in great measure successful, to mitigate their destructive effects, established his famous seismological observatory at Shide, Isle of Wight, after his return to England in 1895, and also a series of observing stations covering a great part of the world, through which he was able to study the 'world-shaking' earthquakes which were his chief interest. For many years the cost, apart from the help rendered by the Association, fell upon himself; and as a piece of pioneer work this of Milne's is unsurpassed among those to which the Association has lent its aid. It has been maintained since his death, and his own liberality has been in some measure replaced from other official sources. The seismological station has been re-established at Oxford, since the premises at Shide ceased to be available.

The work on subterranean temperatures, for which grants were made at intervals from 1837 to 1857, was carried out with instruments belonging to the Association. This work was actually set on foot by J. D. Forbes, who in 1832 had presented one of those

'reports on progress' which were in early years requested from prominent scientific men, dealing, in this instance, with meteorology generally. Forbes was able to show that the existence of 'native heat below the invariable stratum' in the body of the earth was proved; but he pointed out that the relation between atmospheric temperature and that of the earth was not sufficiently classified.

Tides and Waves

Progress in knowledge of the tides has been associated with the British Association to a much greater extent than with any other institution of any nationality. This progress the Association has fostered throughout its existence. The first grant which it made in aid of research was one of £20 in 1834 for the reduction of tidal observations; at recent meetings it has given grants for the same purpose, and altogether it has spent over £2600 in this connexion. During the early years of the Association it was mainly Lubbock and Whewell whom it assisted. To these we owe the first reduction of tidal observations on an extensive scale, and the establishment of methods of analysis and prediction which have been very largely used by the principal naval and shipping authorities of the world. When Thomson (Kelvin) conceived the idea of harmonic analysis, he immediately placed its development in the hands of the Association, and the result was the establishment of those methods which have exercised such a profound influence on the subject and become so widely used. When the details of these methods required scrutiny, the Association

appointed a committee to apply it, and the result was its publication of G. H. Darwin's standardisation. When the British Admiralty in the preparation of its tide-tables does not use the methods of Kelvin and Darwin, it uses either those of Lubbock and Whewell or developments of them. The achievements referred to stand out as landmarks in the history of the subject, but the Association has from time to time rendered assistance to other workers on the subject.[1]

The subject of water-waves engaged the attention of the Association in the year 1837, and a committee was appointed to report on the matter. The work fell to Scott Russell, who produced two elaborate and valuable reports, printed in the annual volumes for 1838 and 1844. These include a number of interesting experiments and acute observations; in particular the characteristics of various leading types of waves are analysed with great sagacity. The work is the more remarkable in that it was accomplished with little aid from mathematical theory, which was then in its infancy. Two conspicuous anticipations of later discoveries may be mentioned, viz. the distinction between wave-velocity and group-velocity, and the minimum velocity of capillary waves. The reports, which may still be consulted with advantage, are also of historical interest in relation to subsequent theoretical work of Stokes and others.[2] The practical connexion between these investigations and Russell's work on the form of ships will be noticed elsewhere.

[1] Dr. J. Proudman.

[2] Prof. H. Lamb.

Meteorology and Climatology

It is sometimes to be remarked that researches in a certain direction lapse and are revived after long periods, and the researches supported by the Association in regard to the investigation of the upper atmosphere form a case in point. The work undertaken by James Glaisher in 1859–66, of making temperature and other observations during balloon ascents, followed more or less directly upon the earlier experiments such as the ascents by John Welsh from Kew Observatory in 1852; but after 1866 further investigation was not undertaken by the Association till 1901 though communications on the subject appeared in 1884–87. Glaisher's reports are at once valuable and entertaining, and clearly indicated the way to future research; but in the early part of 1901 'England was the only important country in which no investigation on the upper air was in progress.'[1] Research, however, was then set on foot by the Royal Meteorological Society (of which Mr. W. H. Dines was president), with the help of the Meteorological Office and the secretary to the Meteorological Council, Sir Napier Shaw. The Association also was moved to appoint a committee and to make a grant; this and a committee of the society worked together, and from 1905 onward the Meteorological Office has had its own station for the investigation of the upper air. Among the published results of all this work (the value of which, in view of the development not only of meteorological knowledge, but also of that of

[1] Mr. W. H. Dines.

military and civil aviation, needs no demonstration), special reference should be made to the report on the then state of knowledge of the subject compiled by Messrs. E. Gold and W. A. Harwood, and issued by the Association in 1909, which includes a full historical summary of earlier work, and of the Association's connexion with it.

The support accorded by the Association to the observatory on Ben Nevis is an outstanding example of the sympathy of our body with climatological research. But another branch of the same department of research, that upon British rainfall, calls for fuller notice, because it provides a good example of an investigation of national importance, set on foot by individual genius, supported in its initiatory stages by the Association, and finally passing from private control to that of the State.

In 1861 G. J. Symons began to collect and publish all available records of rainfall in England and Wales ; and extended the area to cover Scotland and Ireland in the following year, when the first volume of *British Rainfall* appeared, giving data for about 500 stations. In the Report of the Association for 1862 a paper by Symons was published, dealing with the data more fully. The Association made its first grant in connexion with the work, to enable Symons to supply rain-gauges to new observers. Symons made further detailed reports in succeeding years, and in 1865 a Rainfall Committee was appointed, with Glaisher as chairman. It was re-elected each year until 1876, and its reports (mainly Symons' work) remain as original documents of great value, as they amplify the material published in *British Rainfall*. In 1876 the authorities of the Association

decided that the work had reached a magnitude beyond their power to maintain in respect either of grants or of publication.

The British Rainfall Organisation had in fact grown into an important institution. The number of rainfall observers had grown from something under 500 in 1861 to practically 2000 in 1876, and Symons had established himself as the leading authority on rainfall. Of the increased number of observers 250 were equipped with instruments at the expense of the British Association, and considerably more were probably recruited as a direct result of the recognition given to the organisation by the Association. Without the prestige which the Rainfall Committee gave to Symons' work, his progress with the development of his great voluntary organisation must have been far slower than it was. It lasted long enough to give a fair start to a system which under the care of its founder continued to develop steadily and acquired vitality enough to maintain an independent existence. The number of observers is no gauge of the scientific value of the work done—that must be deduced from the subject-matter of the annual volumes of *British Rainfall*—but it serves to show how great and sustained was the public interest in the work. The 2000 observers in 1876 had increased to 3500 at the time of Symons' death in 1900, and the first fifteen years of the twentieth century added still another 1500, bringing the whole number up to 5000. There can be no doubt that the help afforded by the British Association in the first fifteen years of the British Rainfall Organisation was most valuable to Symons in laying down the broad lines of independent voluntary co-operation.

The recent development of the organisation has been in the way of making the observations more uniform and accurate, and of applying them to the elucidation of problems of distribution which are of equal scientific and economic importance.[1] Steps were taken in 1910 by Dr. H. R. Mill, who had conducted the organisation since 1901, to establish it on a permanent basis as a voluntary scientific institution under the control of trustees; but in 1919 the failure of his health, and circumstances arising from the war, led the trustees to transfer the organisation to the Meteorological Office, so that it now forms an integral part of the meteorological service of the country, while continuing to make full use of the voluntary labours of the army of observers.

Terrestrial Magnetism

The study of terrestrial magnetism has been fostered in so many directions by the Association that the references to this subject in the list of grants in Appendix I form insufficient evidence by themselves, and (at the risk of a little repetition) it is appropriate here to review the whole matter. So far as the following statement applies to events down to 1858, it is an abridgment of a report to the Council by Sabine in 1859.

The first occurrence, it is believed, of a survey being undertaken for the express purpose of determining the positions and values of the isomagnetic lines of declination, dip, and force corresponding to a particular epoch over the whole face of a country or state, was the magnetic survey of the British

[1] Dr. H. R. Mill.

Islands, executed in 1834–38 by a committee of members of the British Association, acting upon an enlarged view of a suggestion brought before the Association in 1833. At the meeting of the Association in 1838, a resolution was passed recommending to H.M. Government the equipment of a naval expedition for the purpose of making a magnetic survey in the southern portions of the Atlantic and Pacific Oceans. This recommendation, communicated to and concurred in by the Royal Society, gave rise to the voyage of [Sir] James Clark Ross to the Antarctic in 1839–43.[1] A proposition for a magnetic survey of the British possessions in North America was brought before the Association in a report published in 1837, and being subsequently submitted to the Committee of Physics of the Royal Society, received in 1841 the recommendation of the Royal Society to H.M. Government. The survey, having been authorised by the Treasury, was carried on in connexion with the magnetic observatory at Toronto, under the direction of the Superintendent of the Colonial Observatories, by Lieut. Lefroy. The declination observations were reduced and co-ordinated with similar observations made in the succession of Arctic voyages between 1818 and 1855. The survey of Sir James Ross in 1839–44 having left a portion of the magnetic lines in the southern hemisphere undetermined between the meridians of 0° and 125° E., an application was made in 1844 to H.M. Government by the Royal Society, to complete this portion under the direction of the Superintendent of the Colonial Observatories. This was

[1] See, further, Chapter VII, p. 213.

accomplished in 1845 by Lieut. T. E. L. Moore, R.N., and Lieut. Henry Clerk, R.A., in a vessel hired by the Admiralty for the purpose, and despatched from the Cape of Good Hope. At the meeting of the British Association in 1845,[1] a recommendation was made to the Court of Directors of the East India Company, that a magnetic survey should be made of the Indian Seas in connexion with the magnetic observatory at Singapore. This recommendation was communicated to and concurred in by the Royal Society. The survey, having been entrusted to Captain Elliot, of the Madras Engineers, was completed in 1849. A proposition for a magnetic survey of British India having been submitted to the Association, in a report printed in 1837, a scheme for the execution of such a survey was submitted to the Court of Directors of the East India Company by Captain Elliot on his completion of the survey of the Indian Seas; and having been referred to the Royal Society, received their warm approbation. The Court of Directors having approved the scheme suggested by Captain Elliot, that officer proceeded to India in 1852 for the purpose of carrying it into execution, but died shortly after his arrival at Madras, in August 1852, having just commenced the operations of the survey. In 1853 a letter was addressed to the President of the Royal Society by the Prussian Minister, Chevalier Bunsen, recommending, by desire of His Majesty the King of Prussia, the Messrs. Schlagintweit, well known by their physical researches in the eastern and western Alps, as fitting successors to Captain Elliot in the magnetic survey of India.

[1] Further reference to this important occasion will be found in Chapter VII, p. 215.

In transmitting Chevalier Bunsen's letter to the Court of Directors, the Royal Society took occasion to express their strong opinion of the importance of completing this survey, and their belief in the competency of the Messrs. Schlagintweit for such employment. These gentlemen, having been appointed accordingly by the Court of Directors, and supplied with the necessary instruments, in the use of which they were specially instructed at the Kew Observatory, sailed for India in 1855, and continued their observations through the years 1856, 1857, and 1858, during which they determined the magnetic elements at sixty-nine stations in British India, including some stations north of the Himalayan chain.

Twenty years having elapsed since the former survey of the British Islands (referred to in the first paragraph) was made, the British Association deemed that a sufficient interval had passed to make a repetition of the survey desirable, with a view to the investigation of the effects of the secular change which the magnetic lines are known to undergo. Accordingly, at the meeting of the Association in 1857, the same men who had made the survey in 1837 were requested to undertake a fresh survey, and did so. Among later works, that referred to in the list of grants (Appendix I) under the heading of 'Magnetism, Terrestrial,' for the years 1886–88 represents the work of a committee, of which Balfour Stewart was the most active member until his death, which collected an important series of reports and opinions on the methods of comparison and reduction of magnetic observations. The Falmouth Observatory, to which, as the same list shows, grants were made over a period of nearly

twenty years, began its work as a meteorological station in 1868, and a new observatory was erected in 1885. Magnetic observations were initiated in 1887 and were continued down to 1913, when lack of funds and other considerations necessitated the closing of the station. In the previous year a resolution was passed to the effect that a detailed magnetic survey of the British Isles, such as Sir Arthur Rücker and Sir Edward Thorpe had executed for the epoch of 1891, should be repeated, and this, with the concurrence of the Royal Society and other bodies, was duly set on foot, the Association contributing to the cost.

The Sea-level

The work upon the sea-level, to which a small grant was allocated in 1879, consisted of a careful and detailed investigation of the datum level of the Ordnance Survey of Great Britain, 'with a view to its establishment on a surer foundation than hitherto,' together with an elaborate tabulation of other datum-marks for the purpose of comparison.

Electrical Standards

No committee of the Association has carried out work of more far-reaching importance in application than that upon electrical standards. In 1861 a committee was first appointed to consider the subject of standards of electrical resistance, at the suggestion of Thomson (Kelvin). 'When the committee was first appointed no coherent system of units for the measurement of electrical resistance, current, electromotive force, quantity,

or capacity, had met with general approval. The principal object of the committee was, first, to determine what would be the most convenient *unit* of resistance, and, second, what would be the best form and material for the *standard* representing that unit.'[1]

The committee, which during 1862–70 included, in addition to Thomson, Williamson, Wheatstone, Sir Charles Bright, Clerk Maxwell, C. W. Siemens, Balfour Stewart, and others, did much valuable work, and its earlier reports are a mine of useful information.

The idea of a consistent absolute system of units is due to W. Weber. An absolute system is one in which all the units can be directly expressed in terms of some fundamental mechanical units arbitrarily chosen in such a manner as to produce a consistent system in which every number is connected by some known physical law with every other. The fundamental mechanical units universally adopted are those of length, mass, and time, and for these the committee, after much discussion and correspondence, selected the centimetre, the gramme, and the second. Hence arose the C.G.S. system of measurement which has contributed probably more than any other single event to the rapid progress of electricity. For the committee then proceeded to show how the various quantities which occur in electrical measurements were connected with these primary units, and Appendix C to their second report (Newcastle, 1863) is a

[1] Introduction to collected *Reports of the Committee on Electrical Standards*, by Sir R. T. Glazebrook and F. E. Smith (Cambridge, 1913).

document of fundamental importance. It was written by Clerk Maxwell and Fleeming Jenkin. Weber had shown that there were two practical systems possible, the one based on the attraction between two small bodies electrically charged, the other on Örsted's discovery of the action between a current and a magnetic pole. Faraday and Joule had laid the necessary foundations for the work of the committee; Faraday by his discovery of the laws of electro-magnetic induction and of electrolytic action, Joule by his work connecting the strength of a current with the heat it produces in a conductor which it traverses, and hence with the energy to which that heat is equivalent. The application of this leading to a definition of electromotive force in terms of energy is due to Thomson.

These relations when clearly stated lead to definitions of the various electrical quantities; the next step was to translate these definitions into standards of measurement which could be used in trade and manufacture, and thus put the rapidly growing electrical industry on a sound scientific basis.

This work the committee undertook. The fundamental quantities to be measured are electromotive force and current; the ratio of these is known as electrical resistance, and, as resistances are compared more readily than electromotive forces, resistance and current were chosen as fundamental units. Maxwell, Fleeming Jenkin, and Balfour Stewart undertook to realise the unit of resistance to which was given the name ohm; the work was carried out in 1863, and is described in Appendix D to the Report of that year.

Standards representing the ohm were constructed

and methods of comparing resistances devised; Matthiessen investigated the properties of materials suitable for these standards, and Thomson developed a number of the instruments known by his name.

It had become possible to measure the forces arising from electrical actions and to predict the effects which would be produced from currents circulating in conductors, and though much remained to be discovered the path of discovery was found and the consequences of advance along that path were certain. They are seen in the importance of electricity in the world to-day, and it is to the pioneer work of the committee that they are due. The committee was dissolved in 1870. Meanwhile experiments in Germany and America had led to some doubt as to whether the standard resistance of the committee (the British Association unit, as it came to be called) represented the ohm—one thousand million absolute units of resistance—with all the accuracy possible. In consequence, on the suggestion of Ayrton, the committee was re-appointed in 1881. Thenceforth Rayleigh took a leading part in its deliberations. As the consequence of its work the fundamental standards were determined with an accuracy of a few parts in ten thousand; and this led in 1890 to the appointment of the Board of Trade committee on standards for the measurement of electricity for use in trade. As a result the standards recommended by the Association committee became the legal standards for the Empire. After some further discussion and experiments, an International Congress of Electricians met in London in 1908 with Rayleigh as president, and the standards, with some trivial modifications, were accepted as

international standards throughout the world. Thus the foundations of the science of electrical measurement had been truly laid by the committee. Trade and manufacture extend over the world, and the advantages of an international system of units are incalculable.

About 1891 Viriamu Jones interested himself in the work, and along with Ayrton in 1897 designed a new apparatus for carrying out by the method of Lorenz, used by Rayleigh, a determination of the ohm. The same two members brought forward in 1898 proposals for a modified form of ampere balance for measurement of electric current, and were asked to proceed with the construction of an instrument. Viriamu Jones' illness and death prevented the realisation of this plan, and the balance as designed by them with the assistance of Professor Mather was erected in 1906 at the National Physical Laboratory under the supervision of Mr. F. E. Smith. Soon after the death of Viriamu Jones the Drapers' Company offered to find the funds for the erection in his memory of an improved Lorenz apparatus at the National Physical Laboratory. Work on the ampere balance delayed this, but with generous assistance from Messrs. Armstrong, Whitworth & Co. the instrument was ultimately erected to the design of Mr. F. E. Smith, and a full description of it and of the results obtained from its use appears in the *Philosophical Transactions* for 1914. We now are able to realise the electrical units as defined by the committee in 1862 to a few parts in a hundred thousand.

The care of the national standards and the issue of certificates of accuracy for standards are

now vested in the National Physical Laboratory. The committee had in 1881 arranged for the systematic testing of resistance coils, and 'in addition to dealing with the primary electrical standards, the committee have also considered the subjects of platinum-thermometry, thermal and magnetic units, and physical constants in general. During the latter years of the committee's existence it was active in its efforts to promote international uniformity in standards, and for this purpose many experiments were undertaken at the National Physical Laboratory, on behalf of the committee. The appointment by the London Conference of 1908 of an international scientific committee [Lord Rayleigh's Committee] of fifteen to direct work in connexion with the maintenance of electrical standards relieved our committee of much of its responsibility. The main objects for which it had been appointed had been achieved; in all the principal countries of the world the same units of resistance, of current, and of electromotive force had been adopted, and the standards in use were practically identical.' The reports of the committee, which had as usual suffered dispersal through the successive annual volumes published by the Association, were collected in a single volume and published in 1913, as a memorial to the association of Kelvin with the work, the publication being aided by a gift from Mr. R. K. Gray.

Chemical Researches

As an important early example of research in the department of chemistry we may take the report on

the gases evolved from iron furnaces, with reference to the theory of the smelting of iron, presented at the meeting of 1845 by Bunsen and Lyon Playfair. The report includes a close examination of the methods employed in the analysis of gases, and a consideration of the ways in which furnace-gases may be applied to practical purposes, when applied as fuel. The studies of isomeric naphthalene derivatives and of dynamic isomerism were very notable pieces of work supported by the Association in more recent years. At the Aberdeen meeting in 1885 there was an important discussion on electrolysis, and this subject continued to occupy the section in succeeding years. The work of Arrhenius[1] and the theory of ionisation were thus brought into prominence. From 1886 to 1890 a committee worked at the investigation of electrolysis in its physical and chemical bearings, and its reports contain important memoranda (or references to publications elsewhere) by Prof. H. E. Armstrong, Arrhenius, Fitzgerald, Lodge, Rayleigh, Silvanus Thompson, J. J. Thomson, and others. About the same time the section of chemistry was closely concerned with the consideration of solution: committees in 1887–90 discussed its nature and properties and drew up a bibliography of the subject in a series of reports; and at the Leeds meeting in 1890 a discussion on the theory of solution was held, in which not only leading British chemists, but also such distinguished foreign chemists as Ostwald[2] and van 't Hoff[3] took part, the supporters

[1] Of the Nobel Institute, Stockholm.

[2] Sometime professor of physical chemistry, University of Leipzig.

[3] Sometime professor of chemistry, mineralogy, and geology at Amsterdam; subsequently professor to the Prussian Academy of Sciences, Berlin.

both of older and newer doctrines being represented. It has been pointed out[1] that this discussion was prosecuted even more thoroughly outside the section than in it—a pertinent example of what has been indicated elsewhere as the most valuable informal function of the Association. Indeed, at this period the chemists seem to have been specially fortunate in their ability to avail themselves of the opportunity offered by the annual meetings, for only three years earlier, at Manchester in 1887, when Roscoe was President, 'the leading chemists from every civilised country in the world, with few exceptions, were present, and the friendships formed at that time must have been innumerable and priceless.'[2] Certainly it would seem that at this time the wave of inspiration in the chemical section rode high, for it is again during the same period (1888–90) that we find a series of ample reports on the teaching of chemistry.

The Section of Chemistry has adhered perhaps more closely than others to the earlier practice of obtaining 'reports on the state of science' from members specially qualified in particular departments, and a notable development of this practice is found in the series of reports on colloid chemistry which began to appear in 1917, and have been separately published by H.M. Stationery Office on behalf of the Association, with the help of the Scientific and Industrial Research Department as intermediary. The compilation of these reports represents a remarkable effort of voluntary collaboration by experts in all branches of the science of colloid chemistry and its application.

[1] By Prof. Smithells in Sir W. Tilden's life of *Sir William Ramsay.*
[2] Prof. Smithells.

Geology in the Association

With reference to the general relation between the Association and geology, and especially in connexion with research, Sir Archibald Geikie has very kindly contributed the following paragraphs to this record.

'The activities of the British Association may be grouped in four divisions, by each of which the progress of geology has been advanced both in scientific effort and in popularity:

'(1) The fundamental object of the founders of the Association, to foster in the community an interest in and an acquaintance with science in its various branches, by holding annual meetings in different towns all over the United Kingdom, has certainly been successful in the case of geology. Many examples of this influence might be cited. Cavern-exploration may be quoted as an instance. At the time when the question of the antiquity of man was first engaging public attention, the remarkable evidence by the high-level gravels of the Somme valley formed an attractive subject of discussion in Section C. At the Aberdeen meeting in 1859 Sir Charles Lyell announced his belief that man, as shown by his rudely shaped implements of flint, was contemporary with the mammoth and other long-extinct species of animals. Some years afterwards the reports of the exploration of the caves of the Torquay district drew crowded audiences to the geological section. For some fifteen years this annual attraction continued to fill the meeting-room and to familiarise the public with the nature of the evidence, the objects found being exhibited. It was shown that in the lower part of the material which had accumulated on the floor of Kent's Cavern a rude type of flint tools was found associated

with the bones of extinct animals, while in the upper part implements of a higher type were exhumed, together with bones of living species of animals.

'Besides the innate interest of the subject, these reports of progress in the excavation of the Devonshire cave owed not a little of their attraction to the remarkable expository power of the explorer, William Pengelly. Torquay being his home, he spent most of his time in superintending the work of excavation, and knew by heart every relic that had been found. To great capacity as a skilful and accurate observer he united a strong sense of humour which found vent from time to time in the midst of his details, when with a flash of wit he alluded to some of his subterranean experiences. His account of each year's results was one of the most prominent incidents at the meetings and always kept the large audience spell-bound.

'A notable and characteristic feature of Section C has always been the encouragement given to local observers to make communications on the geology of the district in which the meeting is held. One or more excursions are also usually organised by the help of resident geologists for the purpose of making the visitors acquainted with any noteworthy points in the local geology. These excursions have not only taught the ordinary natives much which they did not know before about the rocks and scenery of their surroundings, but they have also conferred a much-appreciated benefit on many geologists from a distance who by their means have been enabled to visit geological features which otherwise they might have little chance of seeing.

'(2) There can be no doubt that the general belief is well founded that by bringing men of science together for a few days each year for the purpose of

communicating their experiences in research and discussing methods and problems, the annual gatherings of the British Association have had a most important influence in quickening the onward march of science as a whole. No department has perhaps benefited more from this influence than geology. The annual volumes of the Association's reports, in which the progress of this science is chronicled, form a long series of much interest and value which must be consulted by everyone who desires to trace the successive stages of that progress.

'(3) In another important respect geology lies under deep obligation to the Association for the liberal grants which it has received from the funds annually distributed for the furtherance of research in the various departments of science. Many a geological investigation would never have been undertaken save for the help and encouragements given by these donations. The excavations at Kent's Cavern, above referred to, were substantially aided in this way by annual grants. Indeed, cave-exploration has been assisted by the Association not only in this country, but abroad, for a sum of more than £2600 has during the last fifty years been allotted to this branch of investigation. It will thus be seen that in the long list of the Association's benefactions the science of geology has had its share.

'(4) A less obvious but by no means a negligible influence of the Association on scientific progress should be recognised in the personal intercourse which its meetings provide, not only by bringing the cultivators of each branch of science into touch with each other, but also by commingling all the branches and of forming opportunities for friendly converse, and sometimes conjoint discussions in questions

where more than one branch is interested. Geology has profited much by this annual concourse of scientific men. The Association week is an occasion when the "brethren of the hammer" assemble from all corners of the three kingdoms, and often this is the only time in the whole year when some of them can meet each other. As travelling facilities have year by year increased, geologists have come in greater number from other lands. The Dominions, the United States, and many foreign countries have sent their geological delegates to the meetings, and many lasting friendships have thus been begun or cemented more closely. Every elderly geologist in Britain must look back upon these incidents as among the pleasantest reminiscences of his attendance at the meetings of the Association.'

A few examples of geological researches in which the Association has taken part in later years may be cited. The work of establishing the existence of definite life-zones in the Carboniferous limestone, and the mapping of them, made possible in some detail the understanding of the physical geography of the British area during the period. These researches demonstrated the gradual advance of the Carboniferous sea from south to north and the existence of islands, promontories, and lagoons containing specialised flora and fauna. The investigation of coral reefs contributed to the much-debated question of the structure of atolls, and added to knowledge of the nature and distribution of plant and animal life in their vicinity. The study of the distribution of erratic blocks, assisted by information furnished by a large body of amateur and professional inquirers, pointed the way to new views concerning the condi-

tion of our islands during the Pleistocene glacial period. The study of the distribution of the fossil fauna and flora of the Coal Measures has had an important bearing on the development of some of our concealed coal-fields, rendering it possible in some areas to determine the horizon of a stratum by the study of the fossils obtained from a bore-hole, and so to estimate the probable depth at which a desired seam of coal would be encountered. The systematic study of the fossil flora of the Jurassic rocks of Yorkshire, started by a committee of the Association, has been subsequently continued by other means; and the investigation of the Old Red Sandstone rocks of Rhynie, Aberdeenshire, involves that of plant remains which constitute the oldest known land flora. Lastly, reference is due to the collection of photographs of geological interest, which has been supported gratuitously by a very large number of photographers, professional as well as amateur, and has enabled the formation of series of prints and slides which illustrate the various physical features of the British Islands, and have been extensively used for purposes of instruction in universities and schools.

Zoology and Botany: Exploration

Out of all the zoological and botanical researches with which the Association has been identified, we may appropriately choose for chief notice those in marine biology, because they have been so consistently supported from the earliest years. Under the auspices of a committee appointed in 1839, 'for the investigation of British marine zoology by means

of the dredge,' Edward Forbes prepared and presented in 1850 a report in which he remarked that 'British marine invertebrate zoology has advanced with gigantic strides since the year the committee was established.' His own pioneer work was largely responsible for this. In 1843, moreover, he presented the results of his famous work 'On the Mollusca and Radiata of the Ægean Sea, and on their Distribution, considered as bearing on Geology.' This work had been carried out during a voyage of eighteen months on board H.M.S. *Beacon*, in the course of which his health suffered severely. Other workers followed Forbes' lead, and a succession of reports almost annually in the succeeding twenty volumes of the Association testifies to the extension of oceanographical research which led up to the work of the great *Challenger* expedition.

In 1873, at the time when, as recorded elsewhere, the Association was moving with other bodies for the dispatch of that expedition, a committee which included Sclater, Anton Dohrn, Huxley, Wyville Thomson, and Ray Lankester, was reporting upon 'the foundation of zoological stations in different parts of the globe.' The committee's report in that year was able to announce the completion of the zoological station at Naples, under Dohrn's direction, as well as activity elsewhere: thus, Louis Agassiz was at the same time setting up his zoological school on Buzzard Bay in the United States. Dohrn reported that tables at the Naples station had been let to the government authorities of Prussia, Italy, Bavaria, and Baden, and to the University of Strassburg; the University of Cambridge followed this example shortly afterwards, but the British Govern-

ment neither then nor later displayed the active interest of the German in the station. That was left, as commonly in this country, to educational institutions and to bodies like our own. In 1875 the committee in its report described the station, showing how the research tables there were 'each in itself a condensed laboratory,' including chemical reagents, anatomical and microscopical tools and apparatus, and drawing materials. The committee finally suggested to the Association 'whether it would not be fairly within the scope of its actions to undertake the hire of one of these tables,' and that 'the funds of the Association could not be more profitably spent, as far as biological research is concerned.' The suggestion was adopted, and from that time onward a committee of the Association has existed 'to aid competent investigators selected by the committee to carry on definite pieces of work at the zoological station at Naples,' while, as appears from the list in Appendix I (p. 270), a substantial aggregate sum has been contributed to the station in return for the accommodation afforded to British workers nominated by the committee.

In 1893–96 a committee of the Association, with Professor [Sir] W. A. Herdman as secretary, furnished reports on the physical conditions and the zoological, botanical, and geological results of investigations in the Irish Sea. This committee worked in close relationship with the Liverpool Marine Biological Committee, which had established a station at Puffin Island in 1887, and removed to Port Erin, Isle of Man, in 1892.

The committee which was at work on Clare Island, off the west coast of Ireland, in 1909–12, made a

complete biological survey, which (to take a single example of its work) enabled the first thorough account to be given of the zonal and general distribution of seaweeds in relation to habitat on any coast of the British Isles. Other more distant island investigations have included those on Sokotra, off the eastern horn of Africa, of which the flora and fauna were unknown until a committee of the Association undertook the work (1879–82); the investigation into the then state of knowledge of the zoology and botany of the West Indies (1887–97), and the very important investigation of the zoology of the Hawaiian islands [1] (1892–1900).

Several other explorations which received assistance from the Association had valuable results for zoology and botany, although classified under the Section of Geography. Such were the expeditions of Mr. (afterwards Sir) Harry Johnston to Kilimanjaro and the adjacent parts of east central Africa, whose zoological and botanical collections were examined by a series of experts, and Dr. H. O. Forbes' journey in New Guinea. Among other exploring journeys aided by the Association we may instance those of J. Theodore Bent in Abyssinia, those of Bruce in the Antarctic on board the *Scotia*, and in Spitsbergen, and that of Sir Everard im Thurn to Mount Roraima in British Guiana. Other activities of the Association in promulgating geographical exploration appear elsewhere in this record.

Among the many purely botanical researches, reference can only be made to a few. The important and extensive contributions by British botanists

[1] Called the Sandwich Islands in the terms of reference. The memoirs are published under the title of *Fauna Hawaiiensis*.

in the past forty years toward the study of plant physiology are exemplified in our list by the investigations into assimilation in plants and respiration of plants. A leading part, also, has been taken by botanists in this country in the revival of palaeobotany in recent years, and the researches on the structure of fossil plants belong to this department. Knowledge of the nature and details of fertilisation was materially improved by the investigation into fertilisation in Phæophyceæ. That most important branch of recent biological studies called genetics has been supported by the Association through a committee for experimental studies in the physiology of heredity.

Anthropology

In anthropology the Association has assisted the elucidation of current controversies such as the polygenist question, in connexion with which a committee, including Thomas Hodgkin, Owen, J. E. Gray, and Babington, carried out in 1841–44 researches into the varieties of the human race by means of a questionnaire which was widely distributed in all parts of the world. In relation to the study of the antiquity of man, the Association has promulgated the exploration of cave-remains in Malta, Gibraltar, Yorkshire (Settle and other sites), Ireland, North Wales, and Jersey, in addition to that already referred to in connexion with the subject of geology. The investigation into the age of stone circles (1889–1921) also calls for mention here. For the further purpose of organising research, a series of ethnological questions was formulated and distributed in 1853–55; twenty years later instructions for research workers

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in anthropology, and in particular for travellers, were drawn up by a committee which included Francis Galton, Lubbock, Clements Markham, and E. B. Tylor. This committee's work led to the production of a book of *Notes and Queries in Anthropology*, which has passed through three successive editions down to the present time, the Royal Anthropological Institute undertaking the sale. In 1893 a committee in Scotland began the study of Scottish place-names. Its work was merged in that of a larger committee which in 1894 initiated an ethnographical survey of the United Kingdom. This committee published a succession of reports in the annual volumes of the Association down to 1899. It had inquired into places suitable for the survey, as containing populations where there had been comparatively little admixture of race; it had drawn up a code of instructions for observers, and had enlisted the voluntary assistance of local societies and local observers in making measurements, collecting items of folk-lore, and otherwise. It concluded its labours with the hope that the work would be continued by a body possessing ampler means.

Anthropometric investigations in the British Isles have engaged the attention of the Association with little intermission from 1875 down to recent years. Of the various committees which have dealt with this subject from various aspects, that which was appointed in 1875 to collect observations of the height, weight, and other physical characters of the inhabitants of our islands, and presented its final report in 1883, is of particular note because upon its work were based all more recent standards and estimates, and its results were found of particular importance when the country was forced to take stock of its man-

hood during the war of 1914–18. The Association, from the beginning of the present century, has taken an active part in the organisation of anthropological teaching. Special researches which have been maintained wholly or in part for long periods include the study of the north-west tribes of Canada (1886–98) followed by the ethnographical survey of Canada (1898–1909), which, as will be seen in the following chapter, resulted in the transference of the work to the Dominion Government. The famous explorations in Crete (at Knossos) which revealed the early Mediterranean civilisation centred in that island, were assisted by the Association for a considerable period (1901–9); at home, the exploration of the ancient lake-village at Glastonbury may be mentioned in the same category. Among important enterprises which the Association has assisted in early stages the Palestine Exploration Fund is an example: the Association made grants to this fund down to 1875, at which time, it may be recalled, the late Lord Kitchener was engaged upon the survey. Other examples are provided by the work of the anthropological expedition to Torres Straits (northern Queensland and New Guinea, 1898), of which the results were published in a series of memoirs by the University of Cambridge; by the anthropometric study of Egyptian soldiers in 1902–5, which led to an ethnographical survey of the Anglo-Egyptian Sudan by the Sudan Government; and by some of the earlier excavations on Roman sites in Britain (at Uriconium in 1861 and at Silchester in 1897–1901). The special object of this last committee, since 1897, was to ensure that excavators trained in archaeology should not neglect the relics of early man and of ancient animals and plants which they encountered.

As a result of its work, the collection and description of such remains is now recognised as a duty of every trained excavator, and through this new collaboration of experts in sciences at first sight unrelated, additions have been made to knowledge of the historical botany and zoology of the British Isles.

Physiology

Among the physiological researches which have yielded results of permanent value we find, in the earliest years, Williams' experiments on the lungs and bronchi (1840), and the inquiry into asphyxia entrusted to Erichsen and Sharpey (1844). In 1861–1863 a committee reported upon 'The Effect of Prison Diet and Discipline upon the Bodily Functions of Prisoners,' and incidentally revealed in its report that uniformity was wholly wanting, not only in the dietary, but also in systems of punishment, so that 'those who are condemned to imprisonment receive very different treatment in different parts of the kingdom.' 'In some [county prisons] the treadwheel and crank are exceptional employments; in others they are universally used for a small part of the sentence; whilst in a third class they are the constant employments during the whole term of imprisonment.' 'Oakum-picking is no labour in one prison, and hard labour in another; . . . in some the cat is so heavy, and the officer's arm so strong and willing, that the prisoner is for a time made insensible to pain after a few strokes, whilst in other prisons it is so light as to leave very little evidence of its use.'[1] There was one gaol in which bread and water were

[1] *Report*, 1861, pp. 44 *et seq.*

still found to constitute the ordinary dietary. Considering this report at large, it cannot be doubted that in asking for it the Association performed a very notable public service.

In 1868–69 Drs. Crum Brown and T. R. Fraser investigated and reported upon the connexion between change of chemical constitution and change of physiological activity, applying their methods to the alkaloids, atropin, conia, trimethylamine, etc. In 1875 Fraser presented another report on the 'Antagonism between the Action of Active Substances,' in which he indicated the results of experiments on 'the influence of atropin upon the lateral action of physostigma,' showing the effect of the former as an antidote to a dose of the latter 'considerably greater than the minimum lethal.'

From 1892 onward a committee, of which Sir Douglas Galton was the first chairman, acted at first in conjunction with the International Congress of Hygiene and Demography, and latterly with the Childhood Society, in investigating mental and physical deviations from the normal among children in public elementary and other schools, thus identifying the Association with one of the most valuable branches of child-welfare work, which has since been very widely extended. Some of the more important directions of physiological research in recent years are indicated by such subjects of study as the ductless glands, the histology of supra-renal capsules, the vascular supply of secreting glands, reflex muscular rhythm, the structure and functions of the mammalian heart, the electromotive phenomena of the heart, and the 'metabolic balance sheet'—all these, among others, appear in the list in Appendix I.

Economics

The preliminary ventilation of questions of public interest, upon which the Association may, and often does, prepare the way for action, is clearly illustrated by the committee work of the Section of Economics. In its earliest years (before even the title of 'economic science' was accorded to it) it found matter for inquiry in the collection of statistics relating to railways and collieries, and of vital statistics, and was instrumental in demonstrating the necessity of adequate and systematic records in these connexions. In 1872 a committee which included Stafford Northcote, Adderley, Frankland, Leone Levi, Siemens, Williamson, and Fairbairn, reported in favour of the adoption of the metric system of weights and measures, and 'it seems noteworthy that so influential a committee should have arrived at a definite conclusion, without a greater result on public opinion and on legislation.'[1] A committee reported in 1874 upon the economic effects of trade unions, which later occupied much of the attention of the section, down to the years 1916–18, when a committee considered the question of labour unrest, and made recommendations. It may be observed here that this was not the only matter of paramount importance to the nation which was investigated by committees of the section during the war years, 1914–18, and after; we shall find other examples presently.

In our first chapter we have quoted Brewster's dissatisfaction at 'the unjust and oppressive tribute

[1] Sir Edward Brabrook, to whom the compiler's thanks are due for valuable advice upon the activities of Section F in this and other directions.

which the patent law exacts from inventors.' The remedy took time to obtain, but the Association was instrumental in obtaining it. In 1879 a committee on the Patent Law supported the Government bill of that year, and proposed certain amendments, which might have been adopted; but the bill failed to pass. In 1882 and 1883 Sir John Lubbock (president of the Association in 1881) introduced a bill on behalf of the Society of Arts that had been approved by our committee. In 1883 a Government bill was passed: it did not satisfy the views of the Association, but an amending bill was passed in 1885. The work of the Association in this connexion represents one of the most powerful public acts in its history.

Levi obtained a committee on wages and their application in 1880, and his estimates of the income of the people and their 'net or national,' 'gross or personal' expenditure, furnished in the reports of 1881–2, are of retrospective interest. In 1885 a committee was appointed to consider sliding scales and wages lists, and in 1887 it reported on the regulation of wages by means of lists in the cotton industry. It approved the principles of these lists, but concluded that they had not succeeded in removing all probability of industrial disputes. In view of the comparisons of prices with those of July 1914, which have become familiar to us in more recent years, it is of some interest to observe that in 1890 a committee of the Economics Section proposed the adoption of an official index number for the prices of commodities. In 1900 a committee on the economic effect of legislation regulating women's labour was appointed at the instance of the late Mrs. Ramsay Macdonald,

and later, during the war, another committee investigated the replacement of men by women in industry. The accuracy and comparability of British and foreign statistics of international trade (a matter which also has been discussed, since the war, with reference to imperial statistics) was reported upon by a committee in 1905, which encountered much difficulty in dealing with such statistics as were available, and made recommendations for the reform of the system. More than one committee have considered the principles upon which income tax should be levied and exemptions made, and their inquiries were only superseded by those of the Royal Commission which has recently reported.

The labours of the committees which have been mentioned as dealing with questions arising out of the war, to which must be added those of the committee on credit, currency, and finance, resulted in the adoption of an exceptional method of publication by the Association. The results were collected in a series of four volumes under the general editorship of Professor A. W. Kirkaldy, of University College, Nottingham, and published independently with the sanction of the Council: their authority was at once recognised and the demand for them exceeded the supply. The material, therefore, was co-ordinated, supplemented, and brought up to date, and reappeared in its revised form in two volumes respectively entitled *British Finance*, 1914–1921, and *British Labour*, 1914–1921,[1] which together form a record of conditions during and after the war, brought together by voluntary effort beyond praise, which cannot fail to be of lasting value.

[1] Published by Pitman & Sons, 1921.

Educational Problems

In the list in Appendix I we indicate under the heading of Education certain inquiries of dates anterior to the establishment of the Education Section. The earliest of these, which were made from 1835 onward, appear to have been purely statistical inquiries. The Association always took an active interest in education, but demonstrated it rather through the channel of representation to Government authorities (as will appear in Chapter VII under the dates 1854–55 and others) than by means of actual educational research. Sections were sometimes moved to inquire into the state of education in their particular subjects. But the same list reveals the extended and valuable results in the direction of research and inquiry into the scope, means, and methods of education which followed the establishment of the Education Section in 1901.

Engineering and Allied Researches

The Association had in earlier years opportunities of making more spectacular contributions to the advancement of 'mechanical science' than it has now; and it took those opportunities. We have referred in an earlier chapter[1] to the preparatory work which enabled John Scott Russell, at the Dublin meeting in 1857, to give details of the construction of the famous steamer *Great Eastern*, which was then building at his establishment at Millwall. He said that 'the ship, as a naval structure, as far as her lines were concerned, was a child of the British

[1] Chap. III, p. 82.

Association.' At the previous Dublin meeting (1835), he stated, he had 'laid before the Mechanical Section a form of construction which had since become well known as the "wave-line." The section received the idea so well that it appointed a committee to examine into the matter, with the intention, if they found the wave principle to be the true principle, to proclaim it to the world. The committee pursued its investigations, publishing the results in the account of their transactions; and from that time to the present he had continued to make large and small vessels on the wave principle; and the diffusion of the knowledge of this system through the "Transactions of the British Association" had led to its almost universal adoption.' The work of this committee (of which Sir John Robison was chairman) constitutes, then, one of the most important inquiries in applied science ever undertaken by the Association, and its expenditure of nearly £1000 in this connexion must be regarded as a very noteworthy investment. Subsequently the Association took part in many investigations into the use of iron for shipbuilding and other construction, its resistance to projectiles (Fairbairn, 1861), etc.

In regard to the studies upon the strength of engineering materials and changes in the internal constitution of metals under varying conditions of use, which were carried out by Fairbairn and others about 1843–46, it has been stated that Stephenson relied upon these results when designing the Menai Strait tubular railway bridge, and could, indeed, hardly have succeeded without them. Various inquiries, about the same period, into the duties and work of steam engines were found to provide the most valuable data in later years, when it was sought to

estimate the power required for railway running at much higher speeds than had been possible at the time of the committee's researches.

'Even when we enter the domain of practical art,' said John Phillips (presidential address, 1865), 'and apply scientific methods to test a great process of manufacture, we do not fail of success; because we are able to join in united exertion the laborious cultivators of science and the scientific employers of labour. Am I asked to give an example? Let it be iron, the one substance by the possession of which, by the true knowledge and right use of which, more than by any other thing, our national greatness is supported. What are the ores of iron—what the peculiarities and improvements of the smelting processes—what the quality of the iron—its chemical composition—its strength in columns and girders as cast iron; in rails and boiler plate, in tubes and chains, as wrought iron—what are the best forms in which to employ it, the best methods of preserving it from decay? These and many other questions are answered by many special reports in our volumes.'

And finally, reference is due to the work of a committee of the Association on the gauge of small screws. After work extending over the years 1881–84, it recommended a series of small screws which was generally adopted in watch-making and for electric apparatus. Work was subsequently carried on, down to 1903, with a view to overcoming difficulties which arose in the construction of appliances for gauging the threads of screws. A subcommittee of the Engineering Standards Committee, which was appointed by the chief specialist institutions

jointly with Government support, afterwards took up the work of our own committee, so that we have here another example of initiatory effort by the Association. Other inquiries of this type have passed naturally out of the hands of the Association into those of engineering societies, laboratories, and works; but it has remained for the Association, down to the present time, to be identified with such important researches as those on gaseous explosions (in reference to internal combustion engines) and on complex stress distributions in engineering materials.

It must be fully realised that this chapter has attempted no more than to point to a few examples illustrating the wide range of researches which have been fostered by the Association. Looking back over the first decade of the Association's work, Whewell (presidential address 1841) was able to assert that: 'We have found the most gifted and eminent cultivators of science in our own country, and several of those of other countries, ready and willing to undertake for us the office of exploring and interpreting nature—of extending and applying art. No institution, however formed, could have hoped to collect, as its active members, such a body of philosophers as have gladly come forward to labour for us, and have freely given us the resources of their vast powers and matured skill . . . and we have seen a co-operation of experimenters and calculators, observers and generalisers, such as might satisfy the wishes of Bacon himself.'

That spirit of co-operation, engendered during those first ten years, has passed into a tradition not lightly to be broken.

CHAPTER VII

THE ASSOCIATION AND THE STATE

In pursuance of its function of obtaining 'the removal of any disadvantages of a public kind' which impede the progress of science, and, in general, of forwarding scientific interests, the British Association has from time to time approached the British and other governments with specific proposals, requests, or recommendations. Sometimes these have succeeded in their objects; sometimes they have not. In other sections of this book we refer to some of them —in particular, to the relations with various departments of the Government in connexion with Kew Observatory (Chapter V), and to action upon resolutions, involving approach to Government departments, which has arisen out of meetings overseas (Chapter IV).

The earliest instance of approaching the Government appears to have occurred in 1834, and took the form of soliciting a more expeditious publication of the Ordnance Survey maps. A deputation from the Association was received sympathetically by the Chancellor of the Exchequer, and as the Council subsequently congratulates itself on the result, it appears that the desired effect was produced at the time, though not permanently, for we shall find the subject recurring in later years.

In 1837 the Association identified itself with other bodies in moving for an extension of the Ordnance Survey to Scotland. The Council had 'the satisfaction of reporting that this very important national subject, to which public attention was first called by a general vote of the British Association passed at Edinburgh in 1834, has at length been most favourably entertained by the Government, and that measures have been taken for the immediate commencement of the execution of a map of Scotland.' Again, the Association found it necessary, later on, to attempt to keep the Survey authorities up to the mark.

In 1837 the Council is found entering into correspondence directly with the French Government on the subject of international copyright. The inspiration came from the side of the Association: the French authorities were previously exploring, through a Commission, merely the question of copyright at home. The Council also communicated with Mr. Sargeant Talfourd, who had brought forward a bill in the House of Commons for the better securing of copyright to authors. In the following year (1838) the Council was able to report that the matter had been taken up by the British Government, and that a bill had passed both Houses of Parliament defining measures to be adopted in conjunction with foreign Powers to establish a system of international copyright.

In 1838, also, the Association presented a memorial to the Government on the collection and preservation of documents relating to mining operations, pointing out that where such records were not accessible, not only waste and destruction of property

but actually loss of life might ensue, and indeed had done so. This memorial was received with favour, and De la Beche, the founder of the Geological Survey, was authorised to establish a Mining Record Office in conjunction with the Museum of Economic Geology then housed in Craig's Court, Charing Cross.

In the same year (1838) the Association put forward the successful application to the Government for the dispatch of a naval expedition—Ross's expedition—to the South Atlantic and Pacific Oceans, to which reference has been made in Chapter VI (p. 180). Hooker in his presidential address to the Association (1868) referred to the project of this expedition, and stated that:

'I wrote to my friends announcing my resolve to accompany it, in whatever capacity I could obtain a situation amongst its officers. It was thus that my scientific career was first shaped; and it is to this expedition, which was one of the very earliest results of the labours of the British Association, that I am indebted for the honour you have conferred upon me, in placing me in your President's chair.'

It is perhaps most convenient to pursue the subject of this chapter chronologically. It should be explained that it has almost always been the Council which has been the executive body in dealing with Government departments, acting upon resolutions drawn up by sectional or other committees, and forwarded to it by the General Committee, during annual meetings. In this way the Council has sometimes been able, by devoting more time to the consideration of a subject than is possible under the high pressure of an annual meeting, to regulate

any precipitancy in following a line of action which might prove unprofitable.

1842–43.—Application was made to the Government (for which the support of the Royal Society was solicited but refused) to undertake the publication of the catalogue of Stars in the *Histoire Céleste* of Lalande and of Lacaille's *Catalogue of the Stars in the Southern Hemisphere*, which had been reduced and prepared for publication at the expense of the Association. The Lords Commissioners of the Treasury gave directions for 'issuing £1000 for the completion of the works in question' (Aug. 1, 1843). They were published in 1847. (See Chapter VI, p. 170.)

1843–44.—Assistance was obtained from the Commandant of the garrison at Woolwich, through the Master-General of the Ordnance, in experiments with captive balloons.

Application was made to the Government for the insertion of contour lines on the ordnance maps of Ireland. It was understood at the time that this recommendation would be carried out: the process has been slow.

The Government undertook the publication of Professor Edward Forbes' researches in the Ægean Sea. He, as we have seen, was naturalist on board the *Beacon*, survey-ship, during a hydrographical survey of the Mediterranean Sea conducted by direction of the Government, and he explored not only the marine biology but also that of the Ægean Islands and part of Asia Minor (Lycia).

It is already clear that the Association is not in the position of having always asked and never given in its dealings with the Government. In this year the Association transferred to the Museum of

Economic Geology a series of geological sections in railway cuttings, etc., and documents connected therewith, on which it had expended over £360, on the understanding that the work was to be continued at the Government's expense.

1845–46.—At the Cambridge meeting in 1845 important resolutions were adopted by the General Committee on the motion of a conference of scientific men who had taken a leading part in 'the great combined system of magnetical and meteorological observations' which were in progress at the time. This conference acquired an international character from the presence of some of the principal foreign workers in this field, and communications from others who were unable to attend in person. In the following year the Council was able to report the outcome of action upon the resolutions adopted. The resolutions, it is reported, 'received a very favourable consideration from His Majesty's Government . . . [and] from the Hon. Court of Directors of the East India Company.[1] . . . The magnetic observatory at Greenwich is permanently continued upon the most extensive and efficient scale. The magnetical and meteorological observations are constituted a permanent branch of the duties of the astronomical observatories at the Cape of Good Hope, Bombay, and Madras, and arrangements are in progress for making them also a permanent branch of the observations to be made at the observatory at Parramatta. The detachment of the Royal Artillery, by whom the duties at the Cape of Good Hope have been hitherto performed, has been relieved by a permanent increase

[1] See Chap. VI, p. 181.

in the civil strength of the astronomical observatory at that station, and in like manner the officers of the Royal Navy, who now form the establishment of the observatory at Van Diemen Island [Tasmania], will be relieved as soon as the civil establishment at Parramatta is completed. The Ordnance observatories at Toronto and St. Helena are continued until the close of 1848.'

The report further showed that as the result of other recommendations by the Association, a magnetic survey of the Indian Seas had been put in hand by the East India Company, and that a naval officer had undertaken similar work under the direction of the Admiralty in one of the Hudson's Bay Company's vessels in Hudson Bay, with the view of connecting the observations of the Canadian Survey with those of the Franklin expedition in the Arctic region north of America. H.M. Secretary of State for Foreign Affairs acted on a further recommendation, by commending the co-operation of foreign magnetic and meteorological observations to the governments of Russia, Austria, Prussia, Belgium, and Spain. The encouragement by 'specific pecuniary reward' of the improvement of self-recording magnetic and meteorological apparatus was also pressed upon the Government, with successful results.

1846–47.—At the instance of the Council, the Treasury approved the inclusion in the estimates for 1848 of a grant for the publications of meteorological observations made by officers of the Irish Trigonometrical Survey since 1834.

The Council asked for a special survey of the 'parallel roads' of Glen Roy, Scotland, but the Director of the Ordnance Survey preferred that

the work should be taken in the ordinary course of the survey of Scotland then in progress.

1847–48.—In this year, as a result of action by the Association and the Royal Society, the Admiralty undertook to 'appropriate a suitable vessel for the purpose of an investigation into the phenomena of the tides, as soon as the most advisable plan for her employment shall have been determined upon.' A memorial dealing with such a plan was presented by a committee of the Association in 1851. The Court of Directors of the East India Company, under the same inspiration, instituted regular tide observations on the west coast of India, and also allowed the transport to Russia, for purposes of comparison, of the standard bar and scale of the Indian arc of the meridian.

1848–49.—A representation from the Council was instrumental in securing the continuance of the observatory at Toronto.

1849–50.—The Association and the Royal Society acted jointly in recommending the establishment of a reflecting telescope of large optical power at a suitable station for the observation of the nebulæ of the southern hemisphere. The Lords Commissioners of the Treasury, however, pleaded 'so much difficulty attending on the arrangements which alone could render any scheme of this kind really beneficial to the purposes of science,' as their reason for rejecting the proposal at the moment. The proposal, however, when revived in 1852–53, was more favourably received.

An application was made, and was favourably received, for the publication of the British arc of the meridian to its full extent.

1850–51.—In connexion with the Ordnance Survey of Scotland, a memorial was presented to the Government pointing out that in sixteen years only Wigtownshire (less than a sixtieth part of Scotland) had been mapped: this memorial was followed by the appointment of a committee of the House of Commons to inquire into the whole subject of the survey.

The Council's report of this year contains a special tribute to 'the courtesy with which applications on the part of the Association have been received' by the Government, and to its general readiness to comply with them.

1851–52.—The Council reports its failure to obtain a Government grant towards the publication of Huxley's zoological and anatomical researches made during the voyage of H.M.S. *Rattlesnake*. The Council also prepared to take action relating to the publication of Hooker's researches on Indian botany, and of Strachey's explorations in the Himalayas and Tibet, but their wishes in these important matters were found to have been fortunately forestalled.

1852–53.—Correspondence took place between the President of the Association, the Director of the Coast Survey of the United States of America, and the Hydrographer of the Admiralty, on the subject of investigating the zoology and botany of the Gulf Stream in connexion with its hydrographic survey.

Instruments were supplied by the Master General and Board of Ordnance, at the instance of the Association, for measuring the direction and amount of earthquake vibrations in the Ionian Islands.

1853–54.—About four years earlier than this date proposals had been discussed for the formation into a committee of 'members of the Association who are also members of the legislature.' The first idea seems to have been that any person combining these two qualifications should *ipso facto* belong to the committee; but the obvious possibilities of complications arising from such a practice led the General Committee to limit the new body (which became known as the Parliamentary Committee) to selected members of both Houses of Parliament who belonged to the Association. The conception no doubt was meritorious, though (as will appear later) it did not prove a practical permanent scheme; but on the invitation of the committee it got quickly to work, and at first took off the shoulders of the Council some of the burden of periodical communication with Government authorities. In the year under notice the Council transmits to the General Committee the report of the Parliamentary Committee as part of its own report. Representations by members of the committee helped to lead the Board of Trade to improve conditions and facilities for navigation, and for accumulating marine meteorological data on a large scale. The scheme, with which a famous American name is associated—that of Lieut. Maury—affords another illustration of effective co-operation between the Association and the Royal Society. The Committee also reported some interesting correspondence which had passed between it and the Earl of Aberdeen on the principles governing the award of Civil List Pensions, in relation to scientific workers.

The Parliamentary Committee also reports in

this year that 'the Royal Society Council having referred the question of the proposed juxtaposition of scientific societies' to it, several of its members accompanied a deputation to the Chief Commissioner of Works to discuss the possible allocation of accommodation for scientific societies in Burlington House.[1]

1854–55.—The Parliamentary Committee presented a report on a very large question which had been referred to it—whether any measures could be adopted by the Government or Parliament that would improve the position of science or its cultivators in this country. This is a document of no little interest. Most of its arguments continue to ring familiarly down to the present time, or have only lately ceased to do so. The suggestions which the Committee commends to the attention of Government and other authorities include the following. First of all stand reforms at those universities 'which do not at present exact a certain proficiency in physical science as a condition preliminary to obtaining a degree.' It is almost unnecessary to observe that Oxford University undergoes severe strictures in this connexion from many of the advisers whom the committee consulted. 'It is melancholy,' says one, 'to see the number of Oxford graduates who do not know the elementary principles of a telescope, a barometer, or a steam-engine. The contempt of anything manual or mechanical . . . still prevails to a large extent among the upper classes.' And again, the report quotes that of the Oxford University Commission of the time with reference to 'the inconveniences suffered by Oxford graduates when thrown

[1] See, further, Chap. VIII, p. 252.

suddenly on their own resources, as *e.g.*, in a newly settled country, from the neglect of physical science during their university career.' It may be suggested that alumni of Oxford have ceased to deserve (even if they then deserved) that stigma, apart from consideration of the remedy proposed. Other suggestions, which the Association and other societies have more or less frequently hammered on the anvil of general opinion from that day to this, deal with increase in the numbers of professors of physical science—the committee almost throughout insists upon the pre-eminence of 'physical' science—and the enhancement of the salaries of 'scientific officers.' It discusses pensions, the pecuniary assistance of scientific publications, the extension of museums and public libraries, facilities for the exchange of scientific publications between this country and overseas dominions and foreign lands. The concentration of principal scientific societies in a common building was also referred to, and this desire, though not to be gratified in the case of the Association until about thirty-five years later, was soon to be given effect as regards other societies. But the recommendation on which the committee laid greatest stress was the formation of a Board of Science, possessing 'at once authority and knowledge.' The committee (it is gratifying to notice) does not adopt that tone of unrelieved complaint which has been not uncommon in the attitude of unofficial science toward the State: although, 'owing to the system which prevails in this country, of each successive Government striving to outvie its predecessors in popularity by the reduction of public burdens, there is a temptation sometimes to withhold grants' for

scientific purposes, nevertheless 'it would be unfair not to remark . . . that the Government has already taken very important steps in the right direction, and has supplied very pressing wants by the establishment of the Department of Practical Geology, and of the Marine Department of the Board of Trade, and its office for the discussion of nautical and meteorological data. Much yet remains to be done; but these and other acts . . . such in particular as the £1000 grant to the Royal Society [the annual Government grant which had recently been accorded] are an earnest that a disposition is not wanting "to lend science a helping hand."' As regards the Board of Science and other proposals, however, the Council, in a comment on the Committee's report, showed itself understanding of the times: 'other suggestions of the Parliamentary Committee such as those touching the support by the State of lectures on science in the provincial towns,—touching the question of rewards to be given in various shapes to the cultivators of science, and more especially that of the creation of a Board of Science . . . have yet to receive . . . sanction from public opinion; and more especially from the opinion of men of science themselves.' Sixty years were to pass before the establishment of the Committee of the Privy Council for Scientific and Industrial Research, and the separate department of the Government attached to it. And other suggestions of the Parliamentary Committee, in the report under notice, are still not beyond the stage of periodical discussion with intervals of quiescence.

1856–57.—The general subject of the report outlined above, however, was pursued by the Royal

Society, of which Lord Wrottesley, chairman of the Association's Parliamentary Committee, was President, the Council of the Association acquiescing in a series of resolutions which gave effect to the principal recommendations of the report. These were conveyed to the Government by the President of the Royal Society, and their production in both Houses of Parliament was moved for, but in view of 'the peculiar circumstances under which Parliament met, which have much abridged the time at their disposal for the discussion of any measures of importance' nothing further was done at this time.

The Council asked the Admiralty to publish the results of the trials of steamships employed in the public service, but the Admiralty did not think it proper to publish information about vessels belonging to private companies.

The Council was more successful in urging that an annual expedition should be sent to the Niger: an expedition was undertaken by the Government.

1857–58.—The Association supported a successful application by the Royal Society to the Government for the erection of anemometers at Bermuda and Halifax (Canada), the instruments being made from designs worked out at the Association's observatory at Kew. The Parliamentary Committee moved for and obtained increased accommodation and staff for the Meteorological Department of the Board of Trade. An application to the Government for an expedition to be sent to the Mackenzie River (northern Canada), mainly for the purposes of magnetic observations, was refused. Of much wider interest was another geographical proposal put forward by the Association

at this time, upon which the Parliamentary Committee remarks:

'We anticipate an important accession to our scientific knowledge from the expedition to the Zambezi River, which was sanctioned [by the Government], and sent out under the able conduct of the enterprising and distinguished Livingstone, for this expedition was well supplied with the necessary instruments properly tested at Kew, and comprises those who are fully competent to use them.'

The Parliamentary Committee refers to the 'proposed severance from the British Museum of its Natural History Collections, . . . we know of no measure which might be adopted by the Government or Legislature, which would inflict a deeper injury to science': but no official action by the Association appears in this connexion.

1858–59.—Active measures were in progress in this year for extending the magnetic observations in which the Association's interest had been manifested almost since its foundation, and the Prince Consort (President of the Association, 1859–60) allowed his personal interest in the matter to be invoked.

To lovers of the Alps, but especially to scientific mountaineers, it is of interest to find the Association making application 'to the Sardinian authorities for obtaining additional facilities to scientific men for pursuing their researches on the summits of the Alps.' It was ascertained that 'new regulations on the subject of the guides at Chamounix' were being prepared, 'based upon a principle of wider liberty of action,' and a name famous in Alpine history

appears in this connexion, when it is reported that Professor Tyndall expressed 'his entire satisfaction in the result of the intervention of the British Association.'

1859–60.—'The importance of telegraphic communication between seaports of the British Isles has been the subject of much attention since it was urged on the General Committee by the Aberdeen meeting [1859]. . . . Admiral Fitzroy has been authorised to proceed in bringing to a practical issue the recommendations offered on this subject to the scientific department of the Board of Trade, and [the Council] congratulate the Association on the share they have taken in a cause so dear to humanity.'[1]

The Association collaborated with the Royal Geographical Society in procuring the dispatch of another African expedition, and one of the most noteworthy of all—that under Speke and Grant, when Speke was enabled to verify his previously conceived idea as to the connexion of Victoria Nyanza with the River Nile, and an exploration of the then unknown territory of Uganda was carried out.

1860–61.—Endeavours were renewed to procure the publication of details of steam trials by the Admiralty, but that body did not respond enthusiastically, and pointed out 'that the ships of the Royal Navy only employed steam occasionally, and only as an auxiliary power.'

1862–64.—A committee of the Mechanical and Chemical Sections investigated the application of gun-cotton to purposes of warfare, and following its report, a resolution asked for the appointment of a

[1] Report of the Council.

Royal Commission on the subject. This recommendation was adopted, and reports were subsequently made (1868–69) on the use of gun-cotton not only for naval and military purposes, but also in mining and quarrying.

1863–64.—The position of science in education was to occupy the consideration of the Association for some years. In this year the Parliamentary Committee reported that some of its members were supporting the suggestion of the Royal Commissioners that the study of natural science should be introduced into certain public schools.

1864–67.—The public schools bill which was brought before Parliament in the following year failed to satisfy scientific men, and at the instance of a member of the Parliamentary Committee, evidence was given by Sharpey, Miller, Huxley, and Tyndall on the extent to which physical science might be introduced into the curriculum of the great public schools, and was quoted in the report of a committee of the House of Lords on the bill. The bill did not pass, but public interest was to some extent awakened, and it is recorded that voluntary efforts were made by masters at certain schools to add instruction in natural science to the classical course, while 'some of the boys at Harrow . . . formed themselves into a voluntary association for the pursuit of science.'

The death of Lord Wrottesley was the death-blow of the Parliamentary Committee of the Association. The weakness of the scheme for a Parliamentary committee, unless under a chairman of strong personality and predisposed towards using that quality to keep the Committee active, lay probably in the necessarily frequent changes in its personnel, in

addition to the preoccupation of its members with other claims upon their time. One of its last acts was to lay before the Lord Chancellor the reports of a committee of the Association on scientific evidence in courts of law.

1867–68.—The Council urged upon the Government the importance of transferring the control of the natural history collections of the British Museum from the Board of Trustees to a single Government official.

1868–70.—The Association, returning to the education question, laid before both Houses of Parliament a petition praying for 'such measures as will remedy the existing defects in secondary education in schools.' The Council followed this up by sending a deputation to wait upon the Lord President of the Council, and obtained the appointment of a Royal Commission 'to make inquiry with regard to scientific instruction and the advancement of science.' This was an achievement of no little importance: but procedure by way of a Royal Commission has seldom proved expeditious, and the present instance was not an exception. We may, however, interrupt the chronology of this record by a quotation from the report of the Council for 1875–76:

'The Council . . . waited as a deputation upon the Lord President of the Council and upon the Secretary of State for the Home Department, and urged upon the Government the opinion of the Association that it is of the highest importance to the welfare of this country that the Government should without delay give systematic material aid to the development of the higher scientific education,

in the spirit of the fifth and eighth reports of the Royal Commission on Scientific Instruction and the Advancement of Science; and the Council further urged upon the Government that, in the selection of members of the proposed University Commission, science should be duly represented. The Government promised to give due consideration to the representation of the British Association, and they have increased the amount of the grant to the Royal Society for aiding scientific investigation.'

1870–71.—In the following year the Association turned its attention to elementary education, and the Council, acting as a deputation, invited the Government to include elementary natural science among the subjects for which financial assistance was afforded. The deputation secured a promise that its wishes should be carried out 'so far as circumstances would permit.' A successful effort, also, was made to procure for natural science a recognition, in the form of marks allotted, which it did not previously possess in the scheme for the entrance examination into the new Indian Engineering College.

1872–73.—In connexion with a total eclipse of the sun, the Council obtained from the Government a grant towards the expenses of an expedition to Ceylon, the services of a Government steamer, and the co-operation of the Governor-General of India and the Governor of Ceylon.

The Association co-operated with the Royal Society in securing the dispatch of the most important and comprehensive oceanographical expedition ever organised—that on board the *Challenger* (1872–76), to which reference has been made elsewhere.

An application to the Treasury for funds to

enable the Tidal Committee to make observations and continue their calculations was rejected; but the Government of India agreed to defray the expense of tidal observations in India, and of their reduction.

1872–76.—The General Committee referred to the Council a request for support for the observatory at Mauritius (the resolution was referred to the Council as intended 'to enable an investigation of the cyclones in the *Pacific* Ocean to be carried on' —an oversight which the Council in its report gently rectifies by omitting to specify the ocean involved). The Government declined to help at first, but the staff of the observatory was shortly afterwards increased.

The Indian Government, which had generally shown much consideration towards the Association, obtained at its instance a photoheliograph with the view of assisting in the observation of the transit of Venus in 1874. They also (1876) took measures to act upon a proposal for the permanent establishment of a solar observatory.

The Council (1875) urged upon the Admiralty the desirability of attaching naturalists to survey vessels, more especially when engaged in the survey of unfrequented seas: but from the acknowledgment received it does not appear that the suggestion fired the imagination of the naval authorities.

The Association collaborated with the Royal Geographical and other societies in securing the dispatch of the Arctic expedition of 1875 under Captain George S. Nares, who was recalled from the *Challenger* to take command. The expedition, approaching the polar region by way of Baffin Bay and Smith Sound, explored three hundred miles of unknown coast-line,

and made meteorological, tidal, and magnetic observations in higher latitudes than many of its predecessors.

There follows a period of comparative quiescence in the relations between the Association and the Government. The Association seems now to have relaxed its pressing of the claims of science upon the State for many years; indeed, until quite recently. It is tempting, though possibly dangerous, to try to assign reasons for this change. Had science temporarily won its principal objectives in its relations with the State, and was it, at this moment, briefly resting between two periods of powerful forward movement? Or was the spirit of co-operation, engendered by the Napoleonic wars and the long period of internal dissensions which followed it, at last dying out, to be revived only by the Great War in the present century? Gladstone and Disraeli about this time had reached the high level of power. Silvanus Thompson in his *Life of Lord Kelvin* quotes, and warmly contests, Gladstone's dictum 'that the present is by no means an age abounding in minds of the first order,' suggesting that his attitude toward scientific achievement was one of definite depreciation. It is true that Disraeli in 1873 spoke as follows:

'How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of empires, the change of dynasties, the establishment of governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes, and all the legislators that ever lived.'

But did Gladstone and Disraeli, according to their different lights, introduce—even though unconsciously—some tendency to divergence between the main aims of government and of science? The characters of both men (at least in their capacity as statesmen) make that not inconceivable.

1879–80.—The Council conveyed the thanks of the Association to the First Lord of the Admiralty, the President of the Board of Trade, the French Minister of Public Works, the Belgian Minister of Public Works, and other authorities and individuals, for assistance in carrying out tidal observations and causing them to be communicated to the committee of the Association dealing with that subject. Special reference, it may be added, is made to the collaboration of the Association Française pour l'Avancement des Sciences.

1883–84.—To a request by the Council that a physical and biological survey of Milford Haven and the Pembrokeshire coast should be undertaken, on the plan followed by the American Fisheries Commission, the Treasury returned an answer to the effect that the Admiralty had no vessels available for such service.

Reference has been made in an earlier chapter to the reform of the Patent Law which was taking place about this period, and to the Association's part in it.

1884–85. (See Chapter IV, Montreal Meeting.)

1889–90.—The Council urged upon the Government of India the desirability of procuring anthropometric measurements of a representative series of tribes and castes in the Punjab, Madras, Bombay, the Central Provinces, and Assam, and of including

in the enumerators' schedule of the census of 1891 records not only of caste, but also of endogamous and exogamous groups within the caste to which each man belonged. The proposals were not found wholly feasible, but were received sympathetically, and a full discussion with the Government was not without useful results (see the period 1899–1902, below).

The Council also discussed with the Civil Service Commissioners and other authorities the question of assigning marks for physical qualifications to candidates in competitive examinations for posts where high physical efficiency is advantageous. The Council issued a full memorial on the subject, which, however, had already been under the discussion of the authorities.

The Association also returned in this and the following year to the question of expediting the revision and improving the facilities for the purchase of maps of the Ordnance Survey. A departmental committee was appointed by the Board of Agriculture to inquire into the matter. These steps had little effect at the time, though more recent improvements (still in progress) have taken place along the lines then indicated by the Association.

1892–93.—The Association urged upon the Local Government Board the publication of a report presented by the British Medical Association to the Board upon an examination into deviations from the normal among 50,000 children in various schools: the Board declined.

The Council directed the attention of the Home Office and the naval, military, and Indian authorities toward the anthropometric measurement of criminals

and the system invented by M. Alphonse Bertillon in 1890, which is not so well known.

1896–99.—The Association was fully represented in the course of the preliminary action which led to the appointment of a committee by the Treasury, 'to consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation,' etc. The famous institution which was subsequently established as the result of this inquiry has its origin at a much earlier period, and the British Association is very intimately concerned with it through its initiative and devotion in taking over and maintaining the observatory at Kew, as detailed elsewhere in this record (Chapter V).

A movement for the establishing of a bureau of ethnology for Greater Britain, initiated by the Association at this period, did not meet with the same success; although action was taken in regard to the collection of reports by officers in various territories under the administration of the Foreign Office, at the British Museum. The proposal was a logical result of the broadening of the interests of the Association through its meetings overseas (in Montreal and Toronto), and in dealing with these, in Chapter IV, reference has been made to the important ethnological investigations which the Association itself undertook in connexion with them. In the same chapter are mentioned matters taken up with Government authorities, arising out of the Toronto meeting in 1897.

1899–1902.—Action was taken by the Council in the direction of urging the Government of India (*a*) to take advantage of the forthcoming census of

India to collect various important ethnological data, and (*b*) to give more prominence to botany in the training of Indian forest officers. As regards the first of these requests, the Government did not find the Association's proposals practicable, but it did give instructions for the collection by census superintendents of particulars regarding the 'history, structure, traditions, and religious and social usages of the various tribes and castes,' and put forward a scheme for the encouragement of ethnological investigations independently of the census.

1902–3.—The Council directed the attention of the Office of Works and the Local Government Board to the desirability of appointing an inspector of ancient monuments (a post which had been in abeyance since the death of General Pitt Rivers in 1900), and of taking better measures to protect ancient monuments from destruction. The Government was again approached on this question in 1906, but in neither case was there any immediate response. At the time the responsibility was in the hands of an official who had other occupations as well; but the recommendation took effect in 1910, when an inspector was appointed having no other duties.

1903–4.—The question of 'increased national provision for university education' was taken up. The various universities, university colleges, and other large institutions interested in educational science were approached by the President of the Association, with the result that 'a large and distinguished deputation, including representatives of all the universities, university colleges, and many county, municipal, and other educational authorities in the United Kingdom,' was received by the Prime Minister (Mr. Balfour)

and the Chancellor of the Exchequer (Mr. Austen Chamberlain). It is perhaps of more than academic interest, in view of subsequent events, to quote the replies of the representatives of the Government as summarised in the report of the Council; though it will be apparent that the immediate results were scarcely commensurate even with the labour of organising the deputation which the Association undertook.

'Mr. Balfour, in reply to the deputation, said that he did not suppose there had ever been congregated in one chamber so many representatives of learning in this country, and hoped that they would forgive him if he did not wholly rise to the expectations formed of the answer he had to give on behalf of the Government. The words of his which had been quoted would, he hoped, absolve him from the necessity of again expressing sympathy with what he took to be the main object of the deputation. Though it has been said that we have fallen far behind at least two great countries in our national education, he absolutely denied that there is the smallest sign that in the production of the germinating idea of science we have shown any inferiority. Germany has for many generations pursued the State endowing process of applying science to industry, and in this we are far behind. The system of thought in Germany, the habits of the people, and the Government, in this respect places them at great advantage as compared to us, as far as endowment of universities can help a nation in the industrial struggle. But the mere endowment of universities will not, he thought, add greatly to the output of original work of the first quality. It will provide an education which will

render fit for industrial work persons who, without university education, would be very ill-equipped indeed. He concurred with all the speakers that there is a great financial need, both in the old and new universities, for help towards this object. But there is a still greater need—namely, that capitalists should recognise the necessity of giving employment to those whom the universities turn out. There is some evidence to show that shipbuilders and manufacturers prefer the future captains of industry to begin work early in life in the old way. He thought they were wrong, but they must be convinced that they are wrong, otherwise there will be no advantage in turning out qualified students if employers are content to use the man who acquires his training by actual day-to-day labour, but is not qualified in the higher scientific attainments which are more and more becoming necessary. Another thing we want is the creation of positions which will enable a man who has exceptional gifts of originality in science to devote his life to the subjects of his predilection, so as not to be driven to another kind of life in which he will not be able to render the full service of which he is capable to his country. In Germany such positions, which must in the main be attached to the universities, are more numerous than in this country. He could conceive no more admirable use of any funds which the universities can command than the increase of such positions. Having dealt with the more general aspects of the problem presented by the various speakers, he desired to leave it to the Chancellor of the Exchequer to speak upon the more practical question of what the Government can do and what it cannot do.

'The Chancellor of the Exchequer said that he

wished to express his interest in the work of universities, and recognised the larger part they were likely to play in our national development in the future. He considered it would be a misfortune if it were to be thought that it was the duty of the State to take upon itself the whole or main cost of the higher education of the country, or if the State were to come into such relations towards university education as it occupies towards elementary education. He must bid them consider what control the State would have to exercise, and what restrictions it might feel called upon to impose, if it ever took on itself the duty of supplying to the universities such large grants as had been suggested. State aid must always be accompanied by State control, and it was, he thought, dangerous for the higher education of the country that it should have to conform itself, for the purpose of obtaining grants, to rules and regulations laid down by the Treasury. It would be not less disastrous in the interests of higher education if anything were done to relieve patriotic citizens of that sense of the importance of supporting higher education by voluntary endowment and subscription. The Government had not stinted their contributions to education as a whole. They had been spending large sums on primary and secondary education, which was a necessary equipment for any student who wished to make profitable use of the facilities the universities granted. The Government had shown their interest in universities this year by proposing to Parliament to double the grant recently given to university colleges, and had expressed a hope that in the coming year they might be able again to raise that sum so as, in round figures, to double it once more. We are not enjoying one of

those periods of prosperity when the Treasury could afford to be generous without having to place fresh burdens on the taxpayer. Whatever the claims of university education to further assistance, they must wait further development until the finances of the country are in an easier position. Beyond what he had stated, it would be impossible to make in the next financial year further large contributions to university education. He thought that it would be of some assistance if universities would meanwhile consider to what extent they were willing to come under control if they received grants, to what extent the State was to have a voice in fixing the fees of students, and to what extent it was to direct or influence teaching, whether it was to allocate its assistance to promote special branches of study, or whether it was desired to make every university complete in itself.'

1904–5.—The Council conveyed to the Secretary of State for the Colonies two long memoranda enlarging upon the desirability of organising a central meteorological department for the British Empire.

1905–6.—(Matters taken up with Government authorities, arising out of the meeting in South Africa in 1905, are dealt with in Chapter IV, p. 129.)

1907–8.—A resolution passed by the Sections of Education and Anthropology had its sequel in the issue by the Board of Education of a minute recommending a system of anthropometric observation of children in elementary schools.

1909–10.—(Matters taken up with Government authorities, arising out of the meeting in Winnipeg in 1909, are dealt with in Chapter IV, p. 132.)

1910–14.—The Council endeavoured without success to secure a reduction in the price of certain maps

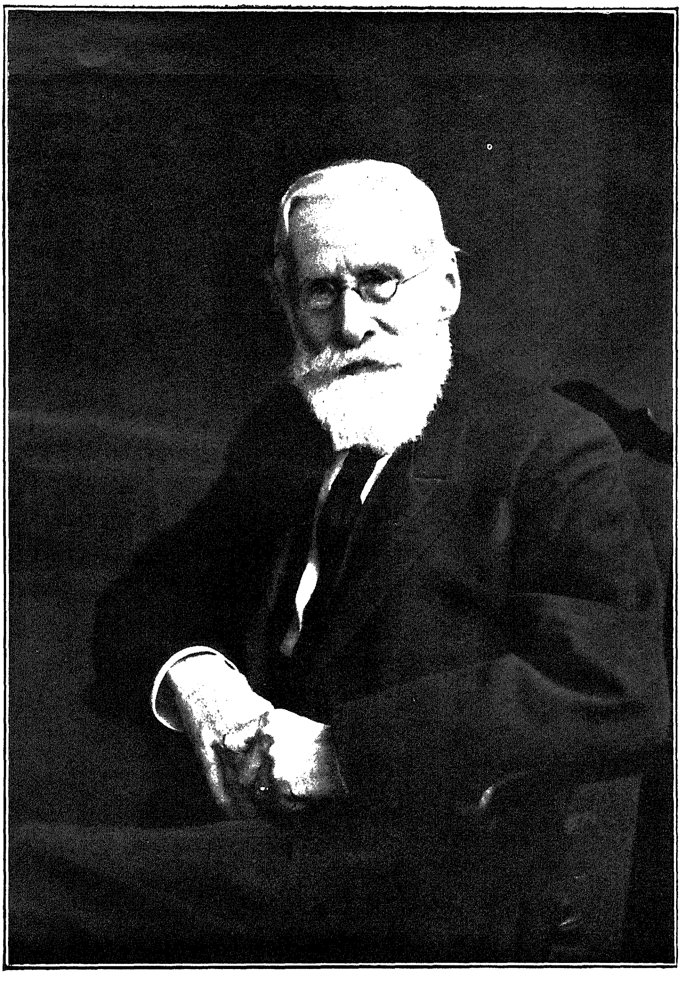
of the Geological Survey. It was more successful in securing from the Colonial Secretary sympathetic and practical attention to 'the defects of the present administration of antiquities in Cyprus.' The Council also supported the General Medical Council in pressing proposals for inquiry into and legislation upon the regulation of the administration of general anæsthetics (1910), and in 1914 returned to this subject, with special reference to the administration of anæsthetics by unregistered persons.

1914–19.—The outbreak of the war in 1914 caused the postponement of the consideration of a number of resolutions passed at the Australian meeting (see Chapter IV), and involving reference to Government authorities. It is scarcely necessary to add that the conditions of war during subsequent years, and the suspension of the Association's meetings in 1917 and 1918, precluded any communications between the Association and the Government, of the nature of those previously discussed.

But, as will appear in the following chapter, the Association was by no means wholly inactive during that period; and in 1919, on resuming its annual meetings, it found many matters arising out of the war to occupy its attention. Before the meeting in that year occasion had been taken to impress upon Government departments the desirability of preserving for ethnological use the data which had been collected in connexion with the issue of travelling passes to the inhabitants of various seats of war, and with the organisation of national service at home. After the meeting in 1919 a resolution was forwarded, strongly urging upon various Government departments the necessity of

organising scientific research in the light of experience gained during the war, in such directions as the investigation of explosives and arms, national health, transport, commerce, and naval and military intelligence. At the Cardiff meeting in 1920 a discussion took place arising out of this resolution, when, among other matters, the work of the newly established department of scientific research at the Admiralty was explained by a representative. A delegation from the Association had previously discussed the same question with the Master-General of the Ordnance at the War Office. Other matters, arising more or less directly out of the war, are still under consideration at the time of writing, but there is already reason to hope that the activities of the Association in regard to them will have profitable results.

It is not pretended that the preceding summary details the whole of the Association's activities in fostering the relations between science and the State: other chapters will furnish additional examples. But an association which has taken the lead, or played a leading part, in impressing upon governments the practical importance of research in different departments of cosmical physics; which has procured investigation into the place of science in education from the kindergarten to the university; which has helped to obtain support for such exploring expeditions as those of Livingstone and Speke and Grant, for most of the later British efforts in the polar regions, and for that on board the *Challenger*; which has addressed departments of State with authority upon so many subjects, ranging from caste to copyright law, has sufficiently demonstrated the breadth of its interests and its power.



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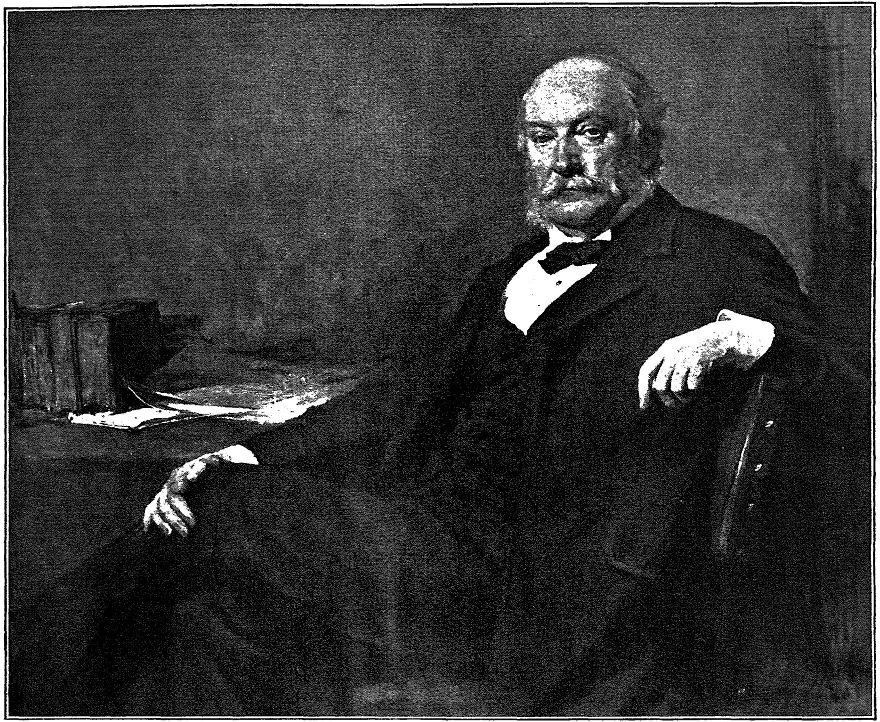

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CHAPTER VIII

RETROSPECT AND PROSPECT

MORE than once the compiler of this record has encountered such a phrase as 'the great days of the Association,' referring vaguely to a period half a century ago. Those who use such words generally have in mind 'great days,' not of the Association, but of science; and even so, if a comparison is intended between the position of scientific achievement then and now, derogatory to the second, it is unjustified. Preceding chapters have indicated that during the first fifty years of the Association's existence, and especially during the later two or three decades of that time, science came to occupy a peculiarly conspicuous position: it was admitted thereto because it was able to stage a succession of wonderful spectacles before the gaze of a ready public, which could entertain itself in appraising or condemning them according to its lights. But if, since then, science has found its main guiding lines leading in a different direction, away from and (in large part) above the level of the public understanding, its achievements along those lines may have been none the less great.

Any seeming aloofness as between scientific achievement and its public appreciation might be expected to react upon an institution whose main

functions are to foster both; and it is perhaps on that account that from time to time critics of the Association have risen to assert either that it is not doing, or that it has done, its proper work. Such a cry arose, for example, about the time of the brilliant 'jubilee' meeting in York (1881), and a few years later, when the Association made its first journey overseas (1884), the position was epitomised in a verse of one of the 'Red Lions'' songs, entitled 'The Travelled Ass':

> At York they thought she was sure to die;
> For she didn't seem to enjoy age;
> But at last the doctors bade her try
> The effects of an ocean voyage.

'Now the voyage is over, the ass is well'—so it was asserted later in the same ballad. But the pessimistic view evidently persisted, for Alfred Newton, in an address to the biological section at Manchester in 1887 (an extraordinarily prosperous meeting), spoke of 'those who believe, as I do, that our Association has no justifiable cause for thinking that its work is accomplished, that it had better settle its worldly affairs, and compose its robes around it in a becoming fashion, before lying down to die.' It is to be inferred from this that the opinion contested by Newton still held ground, and perhaps Sir Douglas Galton had it in mind when, in his presidential address (1895), he concluded a review of the Association's work with the words, 'We exhibit no symptom of decay.'

An organisation of less vitality might easily have been brought to the edge of the grave by the circumstances of the Great War (1914–18). As we have seen, the Association, owing to the preoccupations of those

years, intermitted two annual meetings (1917–18). But its other activities were by no means in abeyance at that time. Research committees remained at work, some of them engaged upon subjects of national importance and upon inquiries directly inspired by war conditions. Such were the economic inquiries into the effects of the war on the national credit, currency, finance, exchanges, and labour conditions, to which reference has already been made (p. 206). The vital question of fuel economy was another topic taken up by a committee. The disruptive effects of the war upon international relations in science led to the consideration, at this period, of measures for the improvement of scientific organisation at home in various special directions. Thus the Association set on foot an inquiry into facilities for the study of geodetic and geophysical problems. Although the much-needed establishment of a permanent institution for this object could not be effected, a committee of the Association did valuable work in 1918–19 in arranging meetings for the discussion of papers and reports on geophysical subjects, and co-operating 'with existing committees in making recommendations for the promotion of the study of such subjects in the British Empire.' This passed more appropriately under the control of a geophysical committee appointed by the Royal Astronomical Society, with representation of other societies interested. The Association's power of initiation is here illustrated afresh.

In 1919 the Association resumed full activity with a very successful meeting at Bournemouth, a place which had never before acted as our host. At this and the following meeting (Cardiff, 1920),

opportunity was taken to discuss the future of the Association, and the discussion, after the latter meeting, was carried on in the columns of *Nature*. Critics, amicable and hostile, set forth their opinions: among these the view reappeared that our body was moribund, if not defunct—a view to be speedily discounted by the fact that the following annual meeting (Edinburgh, 1921) was in point of attendance the tenth largest ever held, and this at a time when financial stringency and high costs were almost, if not quite, as severely felt as they had ever been by the public generally. It had been merely an accident, arising out of negotiations set on foot before war conditions supervened to break the continuity of the annual meetings, that those of 1919–20 should be held in localities where large attendances were not to be foreseen if the conditions of 'geographical control' suggested in a previous chapter (p. 117) held good, as they did.

Of the constructive proposals which emerged from the discussions referred to, one was given prompt effect. It was suggested by a number of commentators and arose out of such observations as the following from a leading article in *Nature*, September 16, 1920: 'Each section is autonomous, and there is no co-ordinating committee to make them part of a composite organisation, or suggest how they may combine their forces for the common good. The Association is like a great industrial works in which each shop produces what it pleases, and no one has the duty of building up a noble structure from the various parts.'

It has already been indicated how measures were immediately taken to overcome this very real defect;

the most important practical step being to summon the organising committees of all the sections in joint and simultaneous sessions, with the special purpose of drawing up a list of major subjects of general interest and importance, for discussion at joint meetings of sections during the ensuing annual meeting. These methods of preparation for the Edinburgh meeting in 1921 ensured a programme which helped to focus public attention upon scientific research as a whole, as the founders of the Association intended that it should be focussed.

Once again we have adverted to the founders of the Association. And it may be suggested that in 1921 the Association was in some sense back in the position in which its founders first placed it. They, indeed, had to construct the engine: we have it, still in running order—so far, the positions differ. They applied its power to driving certain selected mechanism: now, it has come to be inquired how far that mechanism is still effective, and whether in any directions the power might be otherwise applied with better effect. For example, the founders of the Association, having established the principle that annual meetings should be held, and that the receipts by way of membership subscription should be applied to the advancement of science, undertook two chief measures to that end in addition to the actual proceedings at the meetings: namely publication and the financial assistance of research. In each of these directions, circumstances have materially modified the work of the Association.

It was never to be expected that the Association could attempt the publication of the whole of the communications brought before it at an annual

meeting. Of these there are on an average upwards of two hundred in all, some of considerable length, if addresses, discourses, sectional papers, contributions to discussions, and reports of committees be counted. As the number of sections increased and the interests of the Association broadened, so did the dimensions of its published annual reports, culminating in a volume of nearly fifteen hundred pages in 1885. It has often been questioned whether such a receptacle be the most convenient form for the medley of subjects comprised within the purview of the Association, and even so the collection of material in the Report has never been fully representative. Kelvin in 1888 wrote as follows in *The Times*:

'No one not following the course of scientific progress, generally or in some particular department, can fully understand how much of practical impulse is owing to the British Association for the contributions made in the course of the year to the scientific societies and magazines, in which achieved results of scientific investigation are recorded and published.'

This important fact may be illustrated by example. The annual Report takes some months to bring into shape after the annual meeting, and in order to add to its value as a work of reference, it has lately become the practice to ask readers of communications at the meeting, which are not to be published by the Association, to furnish references to their publication elsewhere. Out of 180 communications received at a recent meeting, and not printed by the Association, seventy were published (or arrangements had been made to publish them) in over forty different journals, within six months of the meeting; and this in a year

when the costs of publication were at their highest after the period of the war. This estimate leaves out of account the ample notices which are accorded to the meetings themselves by the Press. The Association, then, is the potential source of an immense bulk and range of scientific literature. But while maintaining this position its own power as a publishing organisation is affected by the increase of costs (and this from a period considerably anterior to the war), unless, by adopting alternative methods of publication, it should discover a wider demand. An endeavour was made to do this by the publication, for the first time in 1920, of *The Advancement of Science*, a book containing the presidential and sectional addresses, during the period of the annual meeting, when public interest far beyond the confines of the meeting-rooms is aroused in them. The immediate success of this measure may indicate further similar possibilities. Tentative suggestions toward the co-ordination of the results of scientific investigations, and the provision of better guidance to those who desire knowledge of those results, have been made more than once before the Association. Such a measure, for example, was in the mind of Kelvin, when in his presidential address (1871) he spoke as follows:

'To give any sketch, however slight, of scientific investigation performed during the past year would, even if I were competent for the task, far exceed the limits within which I am confined on the present occasion' (and even these limits Kelvin at that historic meeting stretched, by all accounts, to the full). 'A detailed account of work done and

knowledge gained in science Britain ought to have every year. . . . It seems to me that to promote the establishment of a British Year Book of Science is an object to which the powerful action of the British Association would be thoroughly appropriate.'

Circumstances, then, have deprived the Association of the power, even if it had the desire, to undertake publication in the bulk to which it attained during the second half of last century and the early years of the present. The same is true in regard to grants for research. Here are involved the considerations, not merely that the Association necessarily has a smaller surplus of receipts than formerly to draw upon for the purpose of aiding research, but also that new sources of provision for research have come into existence since the Association was founded; notably such State institutions as the Department of Scientific and Industrial Research. But it must not be inferred that the British Association (or, for that matter, other scientific institutions) have the less need for public support. It is a widespread public misconception that the great scientific institutions of this country are wealthy: as a class they are not. Probably any one of them—certainly the British Association—could fittingly administer for the advancement of science far larger funds than it commands. To the national well-being science contributes much more than it receives; it has not been its habit to bargain. The name of the British Association has come to carry weight; its name attached to any subject of scientific research or publication is a guarantee of the worth of that subject. But not every item of scientific labour is

competent to command material support on the score of a prompt return from its practical application, and that is why such a body as our Association, able to judge upon internal evidence of both the immediate and the permanent value of any piece of scientific work, should also possess the means to help forward that work, unless some more appropriate source can be found upon which to draw.

And even if this particular field for the expenditure of its funds by the Association were to become narrowed until applications fell short of the available sum (which as yet is very far from probability), there would emerge other measures to which the Association could devote its substance and its influence in aid of science. From time to time proposals have been made (in presidential addresses and elsewhere) to this end: Lockyer's address in 1903 supplies a case in point; but this is not the place to discuss such schemes. One, however, which has modestly and tentatively revealed itself in very recent years may be recorded here as having been brought to the point of practical trial: we refer to it as typical, not isolated. In 1895 Galton pointed out how 'the British Association presents to the young student during its week of meetings easy and continuous social opportunities for making the acquaintance of leaders in science, and thereby obtaining their directing influence.' But it was not until 1920–21, when it became obvious that young workers, in view of the difficulties of the times, could not in any large numbers be expected to find means to attend our annual meetings, that a limited number of science students were invited, on the nomination of certain universities and colleges, and

otherwise, to attend the annual meetings without expense to themselves other than that of membership. The Association was enabled to do this, thanks largely to private liberality: the benefits of such a measure, if it were within the resources of the Association to establish it upon a regular footing, could hardly be over-estimated. A step recently taken toward this object was the provision of a membership fee at half the ordinary rate for university students joining the Association for the first time.

In previous discussion of relations between the State and scientific research and organisation, no reference has been made to a remarkable diversity of outlook which revealed itself in earlier years among the cultivators of science. Brewster has already appeared in these pages (Chapter I) as an admirer of foreign institutions, and in his address in 1850, after quoting a description of the National Institute of France by Playfair, he spoke thus:

'This just eulogy on the National Institute of France . . . may be safely extended to every branch of theoretical and practical science; and I have no hesitation in saying . . . that it is the noblest and most effective institution that ever was organised for the promotion of science. . . . In a great nation like ours, where the higher interests and objects of the State are necessarily organised, it is a singular anomaly that the intellectual interests of the country should, in a great measure, be left to voluntary support and individual zeal. . . . In the history of no civilised people can we find private establishments so generously fostered, so energetically conducted, and so successful in their objects. . . .

Here the speaker named a number of the principal scientific societies, and continued:

'But they are nevertheless defective in their constitution, limited in their operation, and incapable, from their very nature, of developing, and directing, and rewarding the indigenous talent of the country. . . . But were a Royal Academy or Institute, like that of France, established on the basis of our existing institutions, and a class of resident members enabled to devote themselves wholly to science, . . . our universities would then breathe a more vital air. Our science would put forth new energies, and our literature might rise to the high level at which it stands in our sister land.'

Brewster believed that he saw the way opening toward the realisation of his ideal.

'Our institutions have already, to a certain extent, become national ones. Apartments belonging to the nation have been liberally granted to them. . . . Our private institutions have in reality assumed the transition phase, and it requires only an electric spark from some sagacious and patriotic statesman to combine in one noble phalanx the scattered elements of our intellectual greatness, and guide to lofty achievements and glorious triumphs the talent and genius of the nation.'

This view was flatly controverted by Airy from the chair in the following year (1851). 'A wish has sometimes been expressed,' he said, 'that an Academy of Science were established in Britain. In this wish I, personally, do not join. . . . I gratefully acknowledge the services which Government has rendered to science by acceding to the requests

of this and other bodies who have indisputably established claims to their attention; I think it is honourable and advantageous to every party that the Government should occasionally grant personal rewards for important discoveries; I am of opinion that when any branch of science has been put in such a form that it admits of continued improvement under a continued administrative routine, that administration should be undertaken by the Government. But I trust that in all cases the initiative of science will be left to individuals or to independent associations.' In an earlier passage Airy had asserted that 'absence of Government science harmonises well with the peculiarities of our social institutions. In science, as well as in almost everything else, our national genius inclines us to prefer voluntary associations of private persons to organisations of any kind dependent on the State.' This is a familiar view, doubtless more widely held than Brewster's, and repeated by more than one subsequent occupant of the chair of the Association. Owen (address, 1858) foresaw the achievement of the ideal state of scientific organisation through the simple provision of a common dwelling-place for the principal societies. 'In the late location, by liberal permission of the Government, of the Royal, Linnæan, and Chemical Societies,[1] in contiguous

[1] The Royal Astronomical and Geological Societies, the Society of Antiquaries, and the Conjoint Board of Scientific Societies are also located in Burlington House, in addition to the British Association. As for the Association, the need of an independent office in London was not encountered until about 1868. The Council had met at Burlington House since 1862; but in 1870 an office was acquired at 22 Albemarle Street, adjacent to the home of a society whose interests and objects are closely akin to its own—the Royal Institution. It

apartments at Burlington House, we hail the commencement of that organisation, recommended by the British Association at their first meeting, from which the most important results of combination of present scattered powers, and of a system of intellectual co-operation, may be confidently expected.'

If Brewster's ideal, then, be held inconsistent with our 'national genius,' the mere provision of a common building, on the other hand, can hardly be regarded as sufficient to insure complete co-operation in scientific organisation, even if its dimensions were such as to accommodate the representation of all scientific interests (which those of Burlington House are not). Moreover, since the days of Brewster and Airy and Owen, the State has entered the field of scientific research in certain appropriate directions, as exemplified by the work of the Department of Scientific and Industrial Research to which reference has already been made. This should tend toward a more intimate relationship between the Government and scientific bodies; and the British Association, for one, benefited thereby when in 1919 the Department made it a grant toward certain researches for which it desired, in spite of its own war losses, to continue financial assistance.

A middle course has thus been taken between

was not until 1890 that an opportunity arose to transfer the headquarters of the Association to Burlington House: this was done in the following year, but the accommodation which then remained available is possibly not wholly fitting to the status of a body whose powerful aid had been largely instrumental in securing the provision of the building for the uses of science. Such, at least, is the view commonly expressed by those who are compelled to ascend 104 steps from the street-level when visiting the office now in occupation, or to call upon the hospitality of other societies for meeting-places for the Council and committees.

those respectively advocated by Brewster and by Airy, the State and voluntary effort working side by side. It is arguable that the principal danger attendant upon voluntary effort has not been removed; that such effort tends in scientific organisations (as elsewhere) to dissipate itself for want of co-ordination. When the British Association itself was founded, Brewster, as we have seen, saw shortcomings in other scientific societies already existing. Therefore he set on foot a new organisation, disregarding any possibility of enlarging the scope of an existing organisation so as to give effect to his scheme. The British Association justified him by establishing itself as a body addressing the public in the name of science with a voice of peculiar authority, and by promoting 'intercourse between the pursuers of science, both at home and abroad, in a manner which is afforded by no other agency' (Galton). But the mechanism which has succeeded in doing that, is one which may well be employed, and if necessary extended, as an alternative to setting up wholly new machines, to carry out any duty which involves the co-ordination of effort within the body corporate of science itself, or the strengthening of understanding and relationship between science on the one hand, the State and the nation on the other. And in scientific organisation there is work to do in each of these directions.

But whatever drawbacks may attend upon our national conceptions of voluntary service, it is well that its merits should be recognised to the full. To voluntary service in the interests of science the whole record of the British Association stands as one great memorial. Every word spoken at its meetings,

every page of its annual reports, represent voluntary effort on the part of individual 'cultivators of science.' Their attitude toward their craft may be summarised in the words of one of the greatest of them—Rayleigh, who in a sentence of singular beauty, thus concluded his address to the Association in 1884: 'The work may be hard, and the discipline severe; but the interest never fails, and great is the privilege of achievement.'

APPENDIX I

Classified List of Grants Paid by the British Association in Aid of Research, 1834–1921

Section A.—Mathematics and Physics

	£	s.	d.
Alps.—To provide instruments for making Observations and for printing Formulæ for use of Travellers, 1861	6	5	10
Astronomical Clocks, Improvements in, 1879 ...	30	0	0
Atmospheric Air, Researches on, 1839–40 ...	31	16	0
,, Undulations, Researches on, 1839–40 ...	13	3	3
Chronometers (Roberts', in connexion with experiments on Waves and Forms of Vessels), 1842	26	17	6
Constants.—Grant to International Commission of Physical and Chemical Constants, 1911–21	340	0	0
Electrical Resistance, Standards of, 1862–67, 1881–95, 1908–10	1,050	3	4
,, Standards, Free Distribution of, 1863 ...	50	0	0
Electricity.—Influence of Silent Discharge of Electricity on Oxygen and other Gases, 1887–90	41	16	6
Phenomena accompanying Discharge Electricity from Points, 1891–92	60	0	0
Testing Exactness of Ohm's Law, 1876 ...	9	15	0
,, Atmospheric, Observations in India, 1877, and in Madeira, 1879	30	0	0
Electro-analysis, 1902–12	65	0	0
Electro-optics, 1890	50	0	0
Fire-damp in Mines, Instrument for detecting presence of, 1879–80	32	0	0
Geodesy.—Further portion of Geodetic Arc N. of Lake Tanganyika, 1908–10	300	0	0
Geophysical Subjects, To arrange Meetings for Discussion on, etc., 1918–20	26	0	0

	£	s.	d.
Gravity at Sea, Determination of, 1915–21 ...	110	0	0
Heat.—Experiments for testing results of Mathematical Theory of Heat, 1851–54	29	5	10
Experiments on Action of Water at 212° F. on Organic Matter, 1830–40	10	0	0
Experiments on Long-continued Heat, 1836	17	1	0
Heat developed in Combustion, 1837–40 ...	32	6	6
Production of Heat by Motion in Fluids, 1858	20	0	0
Re-measurement of Dynamical Equivalent, 1870–80	106	0	6
Thermal conducting Power of Rocks, 1874–78	24	16	6
Kew Observatory, 1843–72	12,300	1	1
Light.—Action of Gases on, 1842–43	49	10	8
Chemical Action of, 1856	20	0	0
Standards of, 1886–88	109	2	3
Lightning Conductors, Efficacy of, 1874	10	0	0
Magnetic Field, Radiation from a Source of Light in, 1899–1900	75	0	0
,, Survey of the British Isles, 1916 ...	125	0	0
,, Survey of South Africa (continuation), 1906–7	124	19	6
Magnetisation of Iron, Nickel and Cobalt, 1874–75	40	0	0
Magnetism, Terrestrial.—Comparing and reducing Magnetic Observations, 1886–88	51	12	0
Co-operation in Magnetic (and Meteorological) Observations, 1843–45	52	13	10
Falmouth Observatory, 1893–1912	460	0	0
Magnetical Observations (Instruments, etc.), 1840–41	247	12	5
Mathematical Tables, etc. (in chronological order):			
Gaussian Constants, Computation, 1846–47; Re-computation, 1871–73	150	0	0
Desirability of computing or reprinting Mathematical Tables, 1872–76	359	4	2
Elliptical Functions, 1874–77	500	0	0
Factor Tables for 4th, 5th, 6th millions, 1878–79	250	0	0
Fundamental Invariants of Algebraic Forms, 1879–82	121	1	8
Tables in Theory of Numbers, 1885	100	0	0

	£	s.	d.
Mathematical Tables, etc.—*continued.*			
Tables, etc., Pellian Equation, 1890–92 ...	25	0	0
Tables of certain Functions, 1893–1900 ...	130	0	0
Integrals, 1896–99	40	0	0
Bessel Functions, 1908–13	60	0	0
Disposal of Copies of Binary Tables by Presentation, 1914	4	9	0
Tables, Further Calculation, 1916–20 ...	990	0	0
Meteorology, etc.,—Anemometers and Anemometric Observations (Whewell's, Osler's, etc.: Plymouth, Edinburgh, Inverness, etc.), 1841, 1843, 1845–46, 1849	197	13	0
Application of Photography to elucidation of Meteorological Phenomena, 1891–96 ...	55	0	0
Balloon Ascents for Investigation of Atmospheric and Meteorological Conditions, 1859–66	784	11	0
Balloons, Experiments by Captive, 1843, 1846, 1860	92	1	2
Barometer, etc.—Hourly Observations of Barometer and Wet-bulb Hygrometer, etc., 1837	41	18	6
Barometer and Thermometer.—Mountain (provision of, for M'Cord's observations), 1841	6	18	6
Climatology and Hydrography of Central Africa, 1892–98	145	0	0
Connexion of small vertical Disturbances of Atmosphere with Storms, 1862	20	0	0
Effect of Denudation of Timber on Rainfall in North Britain, 1873	20	0	0
Indian Ocean, Synoptic Charts (meteorological), 1885	50	0	0
Investigation of Upper Atmosphere, 1902–14	380	0	0
Mauritius Observatory, 1874	100	0	0
Meteorological Instruments, Observations:			
Edinburgh, 1845	18	11	9
Azores, 1850	25	0	0
Palestine, 1866	50	0	0
Meteorological Instruments and Gratuities to Observers (Forbes), 1843	39	6	0

	£	s.	d.
Meteorology, etc.—*continued.*			
Meteorological Observations (various: Plymouth, Inverness, Kingussie, etc., and reduction of observations), 1838–45 ...	785	16	2
Meteorological Observations on Ben Nevis, 1883–1908	850	0	0
Meteorological Observations near Chepstow, 1884	25	0	0
Montreal Observatory, 1898–1900	70	0	0
Rainfall, British, 1864–76	889	15	8
Rain-gauge Experiments, 1836	9	13	0
Thermometers and Hourly Temperature Observations, 1836	50	0	0
Vertical Movements of Atmosphere with Storms, 1863–64	33	0	0
Wind, Experiments on Force and Velocity of, 1842	10	0	0
Meteoric Dust, collecting and identifying of, 1884–85	90	0	0
Meteors and Aerolites, Luminous, 1863–80 ...	427	0	0
Moon.—Constant of Lunar Nutation, 1836–37 ...	130	0	0
Lunar Committee, to map Surface of Moon, 1866–69	354	13	4
Measurement of Lunar Disturbance of Gravity, 1880–81	60	0	0
Observations of Lunar Objects suspected of Change, 1871–72	40	0	0
Physical Aspect of Moon, 1855	11	8	5
Phillips, Rev. T., for Aid in Transplanting Private Observatory, 1915	20	0	0
Publication.—To confer with Societies publishing Mathematical and Physical Papers as to securing uniform Size for papers of Transactions, etc., 1896	5	0	0
Radio-telegraphic Investigations, 1920	600	0	0
Refraction Experiments, 1836	15	0	0
Sargent, Mr. F., Astronomical Work, 1915 ...	10	0	0
Sea-level.—Considering Datum-level of Ordnance Survey, 1879	10	0	0

	£	s.	d.
Seismology.—Registration of Earthquake Shocks, 1842–43	69	6	6
Transit of Earthquake Waves, 1850, 1857–58	115	0	0
Earthquake Movements, 1855, 1861	35	0	0
Scottish Earthquakes, 1868–76	50	10	0
Earthquakes in Japan, 1881–92	465	0	0
Earth Tremors, 1894–95	125	0	0
Seismological Investigations, 1896–1921 ...	2,620	14	8
Solar Physics.—Action of Gases on Solar Spectrum, 1839	22	0	0
Help in establishing Solar Observatory in Australia, 1909	50	0	0
Photographic Pictures of the Sun, 1862 ...	150	0	0
Solar Radiation.—Provision of two Actinometers for Observations on Solar Radiation to be made by Agassiz in the Alps, 1841 ...	10	0	0
Tables of Sun-heat Co-efficients, 1879–80 ...	80	0	0
Ultra-violet Rays of Solar Spectrum, 1891 ...	50	0	0
Sound under Water, 1867	24	4	0
Spectra.—Photographing Ultra-violet Spark Spectra, 1882–84	33	4	0
Spectral Rays, Transmutation of, 1864	45	0	0
Sprengel Vacuum, Specific inductive Capacity of a good, 1879–80	60	0	0
Stars.—British Association Catalogue (' to extend the Royal Astronomical Society's Catalogue'), 1839–48	1,374	5	6
Reduction of Lacaille's Stars, 1839–41 ...	95	0	6
Reduction of Stars in the Histoire Céleste, 1839–42	658	8	0
Revision of the Nomenclature of Stars, 1841–43	22	8	0
Temperature.—Determinations of High Temperatures, 1874	30	0	0
,, of Volcanic Craters, 1863	100	0	0
Temperature, Subterranean.—Indications of Thermometers sunk to different depths in different soils, 1837–41, 1844, 1857 ...	156	9	1
,, of Mines, 1857	7	8	0
,, Underground, 1868–77	330	0	0

	£	s.	d.
Thermal Conductivity of Iron and other Metals, 1869–72	75	0	0
Thermo-electric Currents, Laws of permanent, 1862–63	20	0	0
Thermometers.—Calibration of Mercurial, 1882 ...	20	0	0
Tides.—Discussions of Observations of the Tides, and the Formation of Tide Tables, 1834–40	608	1	0
Observations at Bristol, 1837–42	395	6	6
,, ,, Leith, 1841	50	0	0
,, ,, Firth of Forth (anomalous Tides), 1843	120	0	0
,, on East Coast of Scotland, 1844	100	0	0
Tidal Calculating Machine, 1876	200	0	0
Tidal Observations, 1862–87	1,180	0	0
Liverpool Tidal Institute, 1920	150	0	0
Water Friction, Laws of, 1880	20	0	0
Water, Gauging of, 1861–62	22	10	0
,, to Floating Bodies, Resistance of, 1866 ...	50	0	0
Wave-lengths, Tables of Inverse, 1872–73 ...	170	0	0
Wave-length Tables of Spectra of Elements, 1882	50	0	0
,, ,, ,, New Series, 1894–1909	99	10	0
Waves.—Experimental Investigations on Waves, Manner in which produced, Effect of Wind, etc., 1837–41	300	12	0
,, Terrestrial Surface-waves and Wave-like Surfaces, 1901–2	20	0	0

Section B.—Chemistry

Absorption Spectra and Chemical Constitution of Organic Compounds, 1917–20	20	0	0
,, ,, and Constitution of Organic Substances, Relation between, 1899–1902	100	0	0
,, Spectra of pure Compounds, 1887 ...	40	0	0
Acids, Synthesis of Organic, 1868–69	72	0	0
Acrid Poisons, 1841	6	0	0
Actinograph, Experiments on the, 1845	15	0	0
Albuminoid Substances of Serum, 1882	10	0	0
Alkaloids.—Chemical Composition and Structure of some of less well-known Alkaloids, 1878–79	50	0	0

	£	s.	d.
Alloys.—Heat of Combination of Metals in Formation of Alloys, 1899	20	0	0
,, Nature of, 1861, 1900	50	0	0
Animal Secretions, Chemical Analysis of, 1839 ...	10	10	6
Aromatic Nitroamines, 1905–15	120	0	0
Benzene, Isomorphous sulphonic Derivatives of, 1900–1	55	0	0
Bone-marrow, Chemistry of, 1901	5	15	11
Bromide of Ammonium, 1863	8	0	0
Carbohydrates of Barley Straw, 1896	50	0	0
Carbon.—Action of Re-agents on Carbon under Pressure, 1863–64	20	0	0
Carbonic Acid, Liquid, in Minerals, 1877	20	0	0
Chemical Constants, Table of, 1837	24	13	6
Chemical Investigations of Natural Plant Products, Victoria, 1915	50	0	0
Chemical Nomenclature	5	0	0
Chemistry, Reports on Progress of, 1871–75 ...	500	0	0
Chlorine, Thermal Equivalents of Oxides of, 1871	10	0	0
Cobalt and Nickel, Double Compounds of, 1877 ...	8	0	0
Colloid Chemistry and its Industrial Application, 1918–21	20	0	0
Colours.—Action of Light on dyed Colours, 1891–99	52	1	8
Colouring matters used in the Arts, 1848 ...	5	0	0
Cresols, Isomeric, and their Derivatives, 1875–76	30	0	0
Crystalline Form with Molecular Structure, Correlation of, 1914	25	0	0
Diazonium Salts, Non-aromatic, 1914–16 ...	13	10	0
Dynamic Isomerism, 1905–17	345	0	0
Electrolysis of Metallic Solutions and Solutions of Compound Salts, 1879	25	0	0
Electrolysis, Physical and Chemical Bearings of, 1886–98	195	0	0
Electrolytic Methods of quantitative Analysis, 1895–1900	45	0	0
Essential Oils, Chemical Constitution and Optical Properties of, 1872–74	80	0	0
Ethyl-bromobutyrate, Action on Ethyl-sodacetoacetate, 1876–77	15	0	0

	£	s.	d.
Flax, Investigations (Chemical) on, 1854–57 ...	16	0	0
Fuel Economy, 1915–20	35	0	0
Gas (Coal).—Development of Light from Coal-gas of different Qualities, 1877	20	0	0
Gases from Iron Furnaces, 1845	50	0	0
„ in deep Well-water, 1860	50	0	0
Haloid Salts, Formation of, 1891–95	57	0	0
Hydracids ; Oxidation in Sunlight, 1888–89 ...	30	0	0
Hydro-aromatic Substances, 1904–14	255	0	0
Inductive Capacity of Crystals and Paraffins, 1880	25	0	0
Iron.—Chemical Constitution of Cast Iron, 1864–70	20	0	0
Iron and Steel, Considering best Method of establishing International Standard for Analysis of, 1890–91	20	0	0
Isomeric Naphthalene Derivatives, Investigation of, 1883–97	155	0	0
Liquids, Specific Volumes of, 1875–76	50	0	0
Manures, Constituents of, 1859–61	70	0	0
Micro-chemistry of Cells, 1899	40	0	0
Nitrogen Acids in Rainfall and Atmosphere, Influence of Weather Conditions on Amount of, 1915	40	0	0
Oxidation of Rails of Railways, 1843	20	0	0
Photographic Chemistry, 1859	10	0	0
Plant Enzymes, 1912–15	95	0	0
Polycyanides of Organic Radicles, 1866	29	0	0
Potash and Phosphoric Acid, Report on Methods employed in Estimation of, 1875–77 ...	24	18	0
Refraction of Solids.—Determining Specific Refractions of Solids from their Solutions, 1881	7	3	1
Rocks and Minerals, Chemico-mechanical Analysis of, 1860–64	51	0	0
Salt Solutions, Vapour Pressures and Refractive Indices of, 1885	25	0	0
Schonbein's Experiments on Connexion between Chemical and Electrical Phenomena, 1840...	40	0	0
Sea-water, Revision of Physical and Chemical Constants of, 1900	100	0	0
Sewage, Treatment and Utilisation of, 1869–73 ...	160	0	0

	£	s.	d.
Solubility of Salts, 1860–61	50	0	0
„ Phenomena, 1914	10	0	0
Solution, Investigation of Nature of, 1887–92 ...	65	0	0
Physical Constants of Solution (especially Constants of Saline Solution), 1885 ...	20	0	0
Steel, Influence of Carbon and other Elements on Corrosion of, 1911	15	0	0
„ Influence of Silicon on, 1887–88	50	0	0
Vitrification, Experiments on, 1831–39 (experimental investigations into the fabrication of glass)	159	4	0
Water Analysis, Uniform System of, 1890 ...	4	1	0

Section C.—Geology

	£	s.	d.
Alum Bay.—Fossil Leaf-bed, 1866–67	40	0	0
Anglesey, Crystalline Rocks of, 1906–11	32	0	0
„ Microscopic Structure of Rocks of, 1887	10	0	0
Atlas Range, Geology and Geography of, 1889 ...	100	0	0
Baluchistan, Mammalian Fauna in Miocene Deposits, Bugti Hills, 1911	75	0	0
Belemnites, British, 1842	50	0	0
Bembridge Limestone at Creechbarrow Hill, 1912	20	0	0
Bournemouth, Fossil Leaf-beds, 1867	30	0	0
Bridlington, Ancient Sea-beach near, 1888 ...	20	0	0
Canada, Pleistocene Flora and Fauna in, 1898–1900	60	0	0
Carboniferous Flora of Lancashire and West Yorkshire, 1887	25	0	0
Life-zones in British Carboniferous Rocks, 1898–1907	95	0	0
„ Polyzoa, 1880–90	80	0	0
Cetiosaurus.—Examination of Locality where Cetiosaurus in Oxford Museum was found, 1896	25	0	0
Charnwood.—Microscopical and Chemical Composition of Charnwood Rocks, 1908 ...	10	0	0
Coal Seams, Geology of, 1920	1	13	0
Conditions of Conversion of Sedimentary Material with Metamorphic Rocks, 1882	10	0	0

	£	s.	d.
Coral Reefs.—Investigations of Coral Reefs by Boring and Sounding, 1896–1902	130	0	0
Corals, Fossil, 1868–73	265	0	0
Chemical and Mineralogical Composition of Rocks, 1862–63	30	0	0
Crustacea, Fossil, 1867–72	100	0	0
Dura Den, Yellow Sandstone of, 1860–61 ...	40	0	0
Further Exploration of Old Red Sandstone, 1913	75	0	0
Erosion of Sea-coasts of England and Wales, 1883–88	20	0	0
Erratic Blocks and Boulders, Mapping Position of, 1874–1908	157	16	6
Eurypterids of Pentland Hills, 1893–96	20	0	0
Fossil Flora, 1868–73	120	0	0
,, Flora and Fauna of Midland Coalfields, 1910	25	0	0
,, Ichthyology, British, 1835–45	620	0	0
,, Mammalia, British, 1842–43	200	0	0
,, Plants, Halifax, 1882–87	145	0	0
,, Reptiles, British, 1839–43	418	2	9
Fossiliferous Drift Deposits at Kirmington, Lincolnshire, and in East Riding of Yorkshire, 1904	50	0	0
Fossils.—List of characteristic Fossils, 1912 ...	5	0	0
Method of Registration of Type Fossils in British Isles, 1891	5	5	0
Monographs on British Fossils, to assist Palaeontographical Society in publication of, 1888	50	0	0
,, Coal, 1863–64	45	0	0
,, in N.W. of Scotland, 1874	2	10	0
Galvanic Experiments on Rocks, 1843	5	8	6
Geological Map of Europe, 1882–84	45	0	0
,, Map of Great Britain and Ireland, for use of Geological Section during Meetings, 1852	15	0	0
,, Record, 1876–91	1,030	0	0
Greenland, Plant Beds of Northern, 1867 ...	100	0	0
Hoxne: Relation of Palaeolithic Deposits to Boulder Clay, 1896	25	0	0

	£	s.	d.
Ichthyosaurus, Viviparous Nature of, 1880 ...	10	0	0
Ightham, High-level Flint-drift near, 1895 ...	10	0	0
Igneous and Associated Rocks, Mayo and Galway, 1909–13	36	13	9
Jurassic Flora of Yorkshire, 1912–14	20	0	0
Kilkenny Coalfields, Fossils of, 1866–67	41	0	0
Kiltorcan Fossils, Kilkenny, 1869–70	40	0	0
Labyrinthodonts of the Coal-measures, 1874 ...	7	15	0
Lanarkshire, Fossil Shells in, 1859	20	0	1
Leaf-beds of Lower Bagshot Series, 1868–71 ...	115	0	0
Lesmahago, Fossils of	15	0	0
Lias.—Fossiliferous Lias beds, Northamptonshire, 1890–91	50	0	0
Limestone.—Faunal Succession in Carboniferous Limestone of British Isles (South-West England), 1907–10	43	0	0
Sections of Mountain Limestone Fossils, 1869–70	50	0	0
Veins containing Organic Remains in Mounttain Limestone, 1868–69	35	0	0
Malta, Fossil Elephants, 1872–73	50	0	0
Man, Isle of.—Remains of Irish Elk in Isle of Man, 1897–1900	35	0	0
'Manure' Gravels, Wexford, 1887–88	20	0	0
Mendip Hills, etc.—Pre-Devonian Rocks of Mendips and Bristol Area, 1908	10	0	0
Mexico, Geology and Zoology of, 1880	50	0	0
Miocene and Tertiary Flora of Basalt of N. of Ireland, 1879–82	55	0	0
Moel Tryfaen, Records of Drift Section at, 1899	5	0	0
Moreseat, Aberdeen, Rocks with Secondary Fossils, 1896	10	0	0
New Red Sandstone, Section of Lower Manchester, 1843	4	4	6
,, ,, ,, and Permian, Underground Waters in, 1875–1903	275	0	0
Nomenclature.—Exact Significance of Local Terms applied in British Isles to Geological and Topographical Objects, 1908	5	0	0
Old Red Sandstone, Fishes of (Scotland), 1841 ...	100	0	0
,, ,, ,, Rocks, Kiltorcan, Ireland, 1913–18	31	0	0

	£	s.	d.
Old Red Sandstone Rocks, Rhynie, Aberdeen, 1916	25	0	0
Onny River, Sedimentary Deposits, 1870 ...	3	0	0
Palaeolithic Rocks.—To excavate Sections in Palaeolithic Rocks in Wales and West of England, 1909	9	0	0
On Lower Palaeolithic Rocks of England and Wales, 1914	15	0	0
Palaeozoic Rocks, Fossil Phyllopoda of, 1883–96	160	0	0
„ „ in England and Wales, to excavate critical sections in, 1920	5	0	0
Peat Deposits, Succession of Plant Remains in 1908	18	0	0
Peat-moss Deposits of Cross Fell, Caithness, and Isle of Man, 1906	25	0	0
Photographs of Geological Interest, Collection, Preservation and Registration of, 1890–1903	82	0	0
Railway Sections, 1841–44	363	6	9
Ramsay Island, Pembroke, Geology of, 1913–14...	20	0	0
Raygill Fissure, Exploration of, 1882–85	35	0	0
St. David's, Excavations in Lingula Flags, 1866	20	0	0
St. Erth, Pliocene Molluscan Fauna of, 1888 ...	50	0	0
Secondary Reptiles, Pterodactyls, and Birds, 1868	30	0	0
Shell-bearing Deposits at Clava, Chapelhall, etc., 1893–96	60	0	0
Shells.—Microscopic Structure of Fossil and Recent Shells, 1844–46	50	0	0
South Africa.—Correlation and Age of South African Strata, 1907–10	15	0	0
Stonesfield Slate: Relation to other Strata, 1894–95	64	0	0
Sub-Wealden Exploration, 1873–75	150	0	0
Tertiary Flora, Collecting and Reporting on, 1881	20	0	0
Trias.—Fauna and Flora of Trias of the British Isles, 1904–9	55	8	1
Fauna and Flora of Trias of Western Midlands, 1914	10	0	0
Vesuvius, Volcanic Phenomena of, 1885–89 ...	95	0	0
Wight, Isle of: Eocene beds, 1887–89	35	0	0

Sections D, K.—Zoology and Botany

(Researches covering both subjects)

	£	s.	d.
Cameroons, Flora and Fauna of, 1887	75	0	0
Clare Island, Botanical, Zoological, and Geological Survey of, 1909–12	135	0	0
Friendly Islands and other Islands in Pacific visited by H.M.S. *Egeria*, Natural History of, 1889	100	0	0
Greenland.—Coast of N. Greenland, Flora and Fauna, 1867	75	0	0
Madagascar, Natural History of, 1857	20	0	0
Maps for Illustration of Geographical Distribution of Animals and Plants, 1841	20	0	0
Natural Products imported into Liverpool, 1857 ; into Scotland, 1858	20	0	0
Nomenclature, Rules of (Reconsideration and Reissue), 1864	5	0	0
Periodical Phenomena of Animals and Vegetables, 1848–56	70	0	0
Preservation of Animal and Vegetable Substances, 1838	19	1	10
Publication, Zoological and Botanical, 1897–99 ...	10	0	0
Sokotra, Natural History, 1879–82	250	0	0
Timor Laut, Natural History, 1882–84	200	0	0
West Indies, Zoology and Botany, 1888–97 ...	540	0	0
Wight, Isle of : Collections to illustrate Natural History, etc., 1912	40	0	0

Section D.—Zoology

Abrolhos Islands and North-west Coast of Australia : Biology, 1915	40	0	0
Ægean and Red Seas, Radiata and Mollusca of, 1841–42	102	0	0
African Lake Fauna, 1896	100	0	0
Annelida, Report on British, 1851–58 ; Report on Irish, 1866	106	0	0
Anoplura Britannica, and Exotic Anoplura, 1842–46	102	12	0

	£	s.	d.
Antarctic Whaling Industry: Assistance for Major Barrett-Hamilton's Expedition to South Georgia to investigate position of, 1914 ...	75	0	0
Apparatus for keeping Aquatic Organisms under definite Physical Conditions, 1899	15	0	0
Ascidians, Compound, of Clyde Area, and other Marine Biological Work at Millport, 1902 ...	25	0	0
Belmullet Whaling Station, Biological Problems incidental to, 1911–16	120	0	0
Birds.—Feeding Habits of British Birds, 1900–11	15	0	0
Migration of Birds (Observations at Lighthouses and Lightships), 1882–88	175	0	0
Migration of Birds (working out Details of Observations), 1897–1902	95	0	0
Osteology of Birds, 1859	50	0	0
Secondary Sexual Character in Birds, 1912 ...	10	0	0
Strickland's Ornithological Synonyms, 1856 ...	100	0	0
Close Time.—Desirability of establishing Indigenous Animals' Close Time, 1876	5	0	0
Crustacea, Colour Physiology of Higher, 1904–6	30	0	0
Devon and Cornwall, Fauna of South Coast, 1868–70	50	0	0
English Channel: Plankton and Physical Conditions, 1899–1900	140	0	0
Entozoa, Reproduction, Development, and Migration of, 1863	25	0	0
Fishes.—Fresh-water Fishes of South Africa (especially of the River Zambezi), 1906 ...	50	0	0
Researches in Food Fishes and Invertebrata, St. Andrews, 1886–88	125	0	0
Structure of Ear in Fishes, 1870	10	0	0
Frog, Influence of Salt and other Solutions on Development of, 1904–6	70	0	0
Granton Marine Biological Station, 1885–87 ...	300	0	0
Herring, Artificial Fecundation of, 1863	20	0	0
Hydroida, Reproductive System of, 1863–64 ...	20	0	0
Index of Genera and Species of Animals, 1893–1914	1,505	0	0
Inheritance in Silkworms, 1918–21	20	2	1
,, of Colour in Lepidoptera, 1920–21 ...	74	0	0

	£	s.	d.
Invertebrata.—Bibliography of Groups, 1884 ...	50	0	0
British Marine Invertebrate Fauna, 1868 ...	100	0	0
Irish Sea, Exploration, 1893–96	155	9	4
Mammoth, Illustrations for Monograph on, 1879 ...	17	0	0
Marine Zoology.—British Seas, 1841–47, 1853–67, 1874–79	852	8	10
Corfu, 1844	10	0	0
Report on Collecting of Objects of Natural History by Mercantile Marine, 1862 ...	5	0	0
To improve and experiment with Deep-sea Tow-net, opening and closing under Water, 1889–92	89	19	3
Marsupials, Collection of, for Work upon Reproductive Apparatus and Brain, 1915	100	0	0
Mascarene Islands, Remains of Extinct Didine Birds, 1866	50	0	0
Medusidae, Report on British, 1859	5	0	0
Mollusca of California, 1857: of N.W. America, 1862	20	0	0
Myxinoid Fishes, Early Stages of Development of, 1875	20	0	0
Naples, Table at Zoological Station, 1876–1920 ...	3,790	0	0
Nomenclature, Zoological, 1865	5	0	0
Oysters, Life Conditions of, under Normal and Abnormal Conditions, 1896–98	100	0	0
Palestine, Insect Fauna, 1867	30	0	0
Plymouth Marine Biological Station, 1887–95 ...	478	10	8
Salmon, Propagation of, 1856–57	20	0	0
Sandwich Islands, Zoology, 1892–94, 1900 ...	400	0	0
Scottish Oceanographical Laboratory, 1917 ...	100	0	0
,, Zoological Station, 1881	50	0	0
Sera and Antisera, Effect on Development of Sexual Cells, 1907	1	11	8
Singapore Caves, Fauna of, 1895	40	0	0
Spectroscopic Investigations of Animal Substances, 1868–69	10	0	0
Symbiosis between Turbellarian Worms and Algæ, 1909	10	0	0
Tasmania, Anatomy and Development of Anaspides and Fauna of Lakes, 1908	40	0	0

	£	s.	d.
Teleostei, Development of Oviduct in, 1888 ...	15	0	0
Terato-embryological Inquiries, 1872	10	0	0
Teredo, etc., Method of preventing Ravages of, in Ships and Harbours, 1862	3	11	0
Testacea, Marine, 1843	10	0	0
Tunicata, Irish, 1859	5	0	0
Zoological Bibliography and Publication, 1920–21	5	13	3
Zoology, Record of Progress, 1868–87	1,900	0	0

Section E.—Geography

Bathy-hypsographical Map of British Isles, 1887...	7	6	0
Bathymetrical Chart of Southern Ocean, 1915 ...	100	0	0
Biskra, Ancient Salt Lakes and other Phenomena, 1909	50	0	0
Exploration.—Abyssinia, 1893–94	35	0	0
Africa, Central, Kilimanjaro and adjacent Regions, 1882–85	1,125	0	0
Antarctic Regions in Area to be explored by Scottish National Antarctic Expedition, 1903	50	0	0
Greenland, 1868	100	0	0
Hadramut, 1895	50	0	0
Indian Ocean.—Expedition to investigate Evidence of Land Connexion between India and South Africa, and Distribution of Marine Animals, 1905, 1908–9	235	0	0
Glacial Region of Karakoram Mts., 1893 ...	50	0	0
Moab, 1871–72	200	0	0
New Guinea, 1885–86	350	0	0
Palestine, 1866–75	250	0	0
Roraima, Mt., 1885	100	0	0
Socotra, 1889	35	0	0
Spitsbergen (Prince Charles Foreland, 1908; Map of do., 1911; Hydrographical Survey of Storfjord, 1915)	110	0	0
Instructions for Travellers, etc., 1875	20	0	0
Lakes, Rivers, and Estuaries in the United Kingdom, Seasonal Variation in Temperature in, 1889–91	50	0	0

	£	s.	d.
Level.—Changes of Land-level of Phlegraean Fields, 1901	50	0	0
Comparative Level of Land and Sea, 1838–40	548	0	10
Oscillation of Land-levels in the Mediterranean Basin, 1907	50	0	0
Map of World, Outline, for Use of Geographical Section, 1855	15	0	0
Maps for School and University Use, Inquiry into Choice and Style of, 1914	40	0	0
Mud in Rivers.—Quantities of Mud and Salt contained in Water of principal Rivers of Great Britain, 1838–41	8	6	6
Place-names, Scottish, 1893	7	0	0
Polar Regions, Depth of Frozen Soil in, 1888 ...	5	0	0
Rainfall and Lake and River Discharge, Quantity and Composition of, 1906	10	0	0
Tidal Bore, Sea Waves, and Beaches, 1903 ...	15	0	0

Section F.—Economics

	£	s.	d.
Collieries.—Inquiry into Statistics of Collieries of Tyne and Wear, 1839	50	0	0
Economic Training, Methods of, 1893–94 ...	12	17	0
Fatigue from Economic Standpoint, 1915–17 ...	90	0	0
Future Dealings in Raw Produce, 1900	2	10	0
Income below Income-tax Limit, Amount and Distribution of, 1910	15	0	0
Industrial Unrest, 1916	20	0	0
Labour, Outlets for, after the War, 1915 ...	100	0	0
Metric System, promoting use of, 1866–72 ...	280	0	0
Money.—Amount of Gold Coinage in Circulation in United Kingdom, 1907–8	12	7	1
Amount of Precious Metals in use as Money, 1888	20	0	0
Variations in Value of Monetary Standard, 1888	10	0	0
Monopolies, State, in other Countries, 1898 ...	15	0	0
Patent Laws, Improvement of, 1862–80	26	6	0
Railways.—Causes of Railway Accidents, 1862 ...	10	0	0
Railway Constants, Experiments to determine Mean Value of, 1838–39	69	19	10

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To co-operate with National Association of Railway Travellers in obtaining travelling facilities for members, 1919...	5	0	0
Sickness and Mortality in York, 1845–46	32	0	0
Trade, International.—Accuracy and Comparability of British and Foreign Statistics of International Trade, 1904–5	29	4	8
,, Unions, Economic Effects of, 1874 ...	25	0	0
Vital Statistics, Inquiry into, 1840–43	186	5	8
Wages, Regulation under Sliding Scale, 1886–1887	20	0	0
War (1914–18).—Effects of War on Credit, Currency, and Finance, 1916–21	110	13	1
Women's Labour.—Economic Effect of Legislation regulating Women's Labour, 1901–3 ...	70	0	0
Replacement of Men by Women in Industry, 1916–18	110	0	11

Section G.—Engineering

Boiler Plates, Strength of, 1852, 1856	20	0	0
Calibrating Instruments in Engineering Laboratories, and comparing measuring Instruments in Use, Methods of, 1895–96 ...	45	0	0
Constant Indicator (for Locomotives) and Dynamometric Instruments, 1842–43	283	9	6
Elasticity of Wires, Secular Experiments on, 1877–80	150	0	0
Engineering Problems affecting future Prosperity of Country, 1916	10	0	0
Gaseous Explosions, 1909–15	442	10	5
Graphic Methods in Mechanical Science, Report of Development of, 1890	11	0	0
High Insulation Key, New Form of, 1880–81 ...	15	0	0
Iron.—Action of Sea Water on Cast and Wrought Iron, 1839–41	100	0	0
Effects of Temperature on Wrought-iron Plates, 1854	10	0	0
Experiments on Hot-blast Iron as compared with Cold-blast Iron, 1838–39	163	0	7

	£	s.	d.
Iron and Steel, Experiments to test Improvements in Manufacture of, 1867–69	125	0	0
Life-boats and Fishing-boats: Statistics and Conditions, Principles of Construction, Use, Establishment around Coasts of United Kingdom, 1857	5	0	0
Metals, Experimental Investigations on Changes in the Internal Constitution of, 1844 ...	50	0	0
Nomenclature in Mechanics, Uniform, 1887 ...	10	0	0
Pyrometer.—Testing Siemens' new Pyrometer, 1874	3	6	0
Road-vehicles to Traction, Resistance of, 1901–1904	185	0	0
Screw Gauges, Determination of, 1883–1902 ...	109	0	0
Ships.—Effect of Propeller on Turning of Steam-vessels, 1876–79	15	0	0
Experiments on the Forms of Vessels, 1840–1844	927	10	0
Steam-vessels, Duty of Engines in (1838–42) and Performances of (1859–69)	987	0	4
Speed of Ships and Currents, Instruments for measuring, 1876–79	27	1	8
Steam-engines.—Researches in the Duties of Steam-engines in Cornwall, 1839	50	0	0
Strength of Materials, 1843–46	220	0	0
Stress Distributions, Complex, in Engineering Materials, 1914–20	220	0	0

Section H.—Anthropology

Anthropological Notes and Queries for Use of Travellers, 1881–1908	199	0	0
Anthropometrical Measurements in Schools, 1894	5	0	0
Artificial Islands in the Highland Lochs, Distribution of, 1911–18	38	0	0
Australia.—Publication of Miss Byrne's Gazetteer and Map of Native Tribes of Australia, 1915	20	0	0
Bath.—Exploration of Roman Baths, 1889 ...	100	0	0
British Isles, Anthropometric Investigations, 1877–84, 1905–7	340	0	0

	£	s.	d.
British Isles—*continued.*			
Ethnographical Survey of United Kingdom, 1894–1902	305	0	0
Bronze Age Implements, Distribution of, 1916–1921	205	18	6
Calculating Measurements taken in Anthropological Laboratory, 1890–94	30	0	0
Canada.—Physical Character, Language, and Social and Industrial Condition of Tribes of N.W. Canada, 1886–98	675	0	0
Caves, exploration,[1]—Borneo, 1879	50	0	0
Calf Hole, near Skipton, 1890–95	15	0	0
Elbolton, near Skipton, to ascertain whether Remains of Palaeolithic Man occur in the Lower Cave Earth, 1891–92	50	0	0
Ireland, 1901–3	100	0	0
,, Fermanagh, 1878–79	20	0	0
,, South, 1880–83	30	0	0
Kent's Hole, 1866–80	1,800	0	0
Malta, 1866	30	0	0
Settle, 1873–78	450	0	0
Ty Newydd, 1899	40	0	0
Uphill, 1899	30	0	0
Wales, North, 1886–87	45	0	0
Crania, Catalogue of, 1866	50	0	0
,, Typical, 1866	30	0	0
Crete, Exploration of, 1901–9	790	0	0
Cyprus, Anthropometric Observations in, 1914 ...	50	0	0
Earthworks, Exploration of, 1877–78	50	0	0
Easter Island, Excavations in, 1912	15	0	0
Egypt.—Anthropometric Investigations among Native Troops of Egyptian Army, 1902–5	38	10	0
Physical Characters of Ancient Egyptians, 1912–17	55	0	0
Racial Photographs from ancient Egyptian Pictures and Sculptures, 1887	20	0	0
Gelligaer, Excavations on Roman Site at, 1902 ...	5	0	0
Glastonbury Lake Village, 1894–1915	327	10	0

[1] Certain of these researches were originated in the Section of Geology, but they are grouped together here for convenience.

	£	s.	d.
Greece.—Neolithic Sites in N. Greece, 1910 ...	5	0	0
Greek Islands, Investigation into a Pre-historic race in, 1886–88	60	0	0
Hastings, Kitchen-midden, and ancient Settlement called Wildernesse, 1895	95	0	0
Hausa.—To produce Copies of Hausa MSS. for Deposit in Centres where Hausa is taught for Government Service, 1913	20	0	0
India.—Psychology and Sociology of Todas and other Tribes of Southern India, 1903 ...	15	0	0
Jersey, Palaeolithic Site in, 1914–20	160	0	0
Loughton Camp Investigation (earthwork), 1883	10	0	0
Macedonia, Excavation of Early Sites in, 1921 ...	50	0	0
Malay Peninsula, Natural History and Ethnology of, 1900	25	0	0
Malta, Archaeological Investigations in, 1915–20...	50	0	0
Mashonaland, Prehistoric Remains in, 1892 ...	50	0	0
Oldbury Hill, near Ightham, Excavations at, 1890–92	35	0	0
Photographs of Anthropological Interest, 1900 ...	10	0	0
Questions for eliciting Ethnological Data; Drafting and Distribution of, 1841–42, 1846, 1851–55	41	15	3
Roman Sites in Britain, 1904–14	125	0	0
Silchester Excavation, 1897–1901	77	10	0
Stone Circles, Age of, 1899–1920	223	13	2
Stone Monuments, Classification and Distribution of Rude, 1920	20	0	0
Sutton Bone Bed, with special reference to Chipped Flints, 1912	15	0	0
Teaching.—Present state of Anthropological Teaching, 1901	5	0	0
Torres Straits, Anthropology and Natural History of, 1898	125	0	0

Section I.—Physiology

	£	s.	d.
Amyl Compounds, Physiological Experiments, 1866	25	0	0
Anæsthetics, Further Clinical and Experimental Knowledge of, 1909–11	70	0	0

	£	s.	d.
Antagonism of Poisonous Substances, 1872 ...	10	0	0
Arum Spadices, Electrical Phenomena and Metabolism of, 1908	10	0	0
Asphyxia, Inquiries into, 1844–46	16	6	2
Physiological Action of Inhalation of Oxygen in Asphyxia, especially in Coal-mines, 1893	20	0	0
Binocular Combination of Kinematograph Pictures and Relation to Binocular Combination of Simpler Perceptions, 1914	0	17	0
Bodily Exercises on Elimination of Nitrogen, Influence of, 1882–83	83	3	3
Calorimetric Observations on Man in Health and Febrile Condition, 1912–14	125	0	0
Cancer, Body Metabolism in, 1908–10	50	0	0
Cerebral Cortex, Comparative Histology of, 1899–1901	15	0	0
Children, Mental and Physical Condition of, 1894–1900	45	0	0
Climate upon Health and Disease, Effect of, 1906–8	110	0	0
Coagulation of the Blood, 1884	100	0	0
Digestion, Course taken by Products of, 1869 ...	10	0	0
Ductless Glands, 1905–17	323	14	8
Electrical Changes accompanying Discharge of Respiratory Centres, 1899	20	0	0
,, ,, in Mammalian Nerve, 1900 ...	20	0	0
,, Impulses through Nerve Structure, Transmission of, 1878	30	0	0
Ethyl and Methyl Series, Physiological Action of, 1867–71	105	0	0
Fatigue, Mental and Muscular, 1909–11	72	17	0
Hæmoglobin, Changes in, and Destruction of Red Corpuscles in Spleen, 1902	15	0	0
Heart.—Power of Mammalian Heart under various External Conditions and Influence of Drugs, 1902	20	0	0
Significance of Electromotive Phenomena of Heart, 1915	20	0	0
Structure and Function of Mammalian Heart, 1894, 1913–14	60	0	0

	£	s.	d.
Heat generated in Arterialisation of Blood, 1870–72	37	2	6
Intestinal Secretions, Nature of, 1874–76... ...	50	0	0
Light, Physiological Action of, 1874	20	0	0
Lungs.—Experiments on the Lungs and Bronchi, 1840	8	13	0
Lymphatic System, Physiology of, 1887–89 ...	75	0	0
Mercury, Action on Secretion of Bile, 1868 ...	25	0	0
'Metabolic Balance-sheet' of the Individual Tissues, 1904–10	200	0	0
Nerve Cells.—Changes associated with Functional Activity of Nerve Cells, 1899	280	0	0
Histological Changes in Nerve Cells, 1899 ...	20	0	0
Nitrite of Amyl, Physiological Action of, 1864 ...	10	0	0
Occupations on Physical Development, Effect of, 1888	25	0	0
Organic Compounds, Physiological Action, 1870–72	55	0	0
Ortho-, Pyro- and Meta-Phosphoric Acid, Physiological Action of, 1877	15	0	0
Oxy-hæmoglobin at High Altitudes, Dissociation of, 1911–13	40	0	0
Peptone and Precursors, Physiological Effect of, 1897–1901	100	0	0
Phonograph, Physiological Applications of, 1895–1898	400	0	0
Phosphates, Metabolism of, 1915	20	0	0
Physiological Operations of Medicinal Agents, 1843–47	60	0	0
Prison Diet and Discipline, Effect of, on Bodily Functions of Prisoners, 1861–63	60	0	0
Proteids, State of Solution of, 1903–6	80	0	0
Psychological War Research (Industrial Fatigue, Alcoholism, etc.), 1917	10	0	0
Pulse Phenomena by Thomson's Siphon Recorder, Investigation of, 1878	10	0	0
Reflex Muscular Rhythm, 1909	10	0	0
Rigor Mortis, 1866	10	0	0
Sound, Physiological Action of, 1876	25	0	0
Supra-renal Capsules, Histology of, 1899–1901 ...	45	0	0
Urine, Mechanism of Secretion of, 1866	10	0	0

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Vascular Nervous System, Influence of Drugs on, 1899	10	0	0
„ Supply of Secreting Glands, 1900 ...	10	0	0
Veins and Absorbents, Communication between, 1841	3	0	0

Section K.—Botany

Assimilation in Plants, 1899	20	0	0
Bahamas, Flora of, 1888	100	0	0
Ceylon.—Botanical Station, Peradeniya, 1888–91	125	0	0
China, Flora of, 1887–89	175	0	0
Cyanophyceae, Investigation of, 1902–3	35	0	0
Cycadaceae, Collection and Investigation of Australian, 1915	25	0	0
Cycads, South African, 1906–7	49	19	4
Dipterocarpeae, Family of, 1877	20	0	0
Disappearance of Native Plants from Local Habitat, 1891	5	0	0
Ditcham Park, Hampshire, Vegetation of, 1913–1914	59	4	3
Electromotive Phenomena in Plants, 1910–11 ...	20	0	0
Fossil Plants, Structure of, 1905–15	131	0	0
Fungi, Ecology of, 1917	8	0	0
Geotropic and Heliotropic Irritability and Curvature, Influence of varying Percentages of Oxygen and various Atmospheric Pressures on, 1915	50	0	0
Growth of Plants, 1860	10	0	0
Growth of Plants under Glass, 1838	75	0	0
Heredity, Experimental Studies in the Physiology of, 1904–21	520	0	0
Jamaica, Renting of Cinchona Botanic Station, 1915–16	37	10	0
Light: Action on Growth of Seeds, 1842; and on Plants, 1844	18	0	0
Marsh Vegetation, 1907–8	30	0	0
Œnothera and other genera, Breeding Experiments on, 1918–21	47	15	0
Peat of Kennet Valley, Flora of, 1914	15	0	0
Phæophyceæ, Fertilisation in, 1897–1901	105	0	0

	£	s.	d.
Photographs, Botanical: Registration of Negatives, 1904–11	33	6	5
Podostemaceae, Morphology, Ecology, and Taxonomy of, 1901	20	0	0
Respiration of Plants, 1903–4	27	0	0
Seeds, Vegetative Power of, 1842–43	13	5	7
„ Vitality of, 1842–58	92	14	6
Solar Radiation etc., Influence on Vital Powers of Plants growing under different Conditions, 1851–53	65	0	0
Wales, Primary Botanical Survey of, 1921 ...	20	0	0

Section L.—Education

	£	s.	d.
Chemistry, Methods of teaching, 1888–90	30	0	0
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Conditions of Health essential to carrying on of Work of Instruction in Schools, 1902–3 ...	5	0	0
Curricula of Secondary Schools, 1909	5	0	0
Educational Charts and Pictures for use in Schools, 1921	6	10	0
Effects of 'Free-Place' System in Secondary Education, 1916–20	40	0	0
Experimental, Observational, and Practical Studies suitable for Elementary Schools, 1906 ...	5	0	0
Industrial and Poor Law Schools, Curricula, etc., 1912	10	0	0
Influence exercised by Universities and Examining Bodies on Secondary Schools Curricula, and of Schools on University requirements, 1902	5	0	0
Influence of School Books on Eyesight, 1912–17...	28	7	6
International Language, Inquiry into practicability of, 1920–21	12	10	0
Mental and Physical Factors involved in Education, 1911–17	60	0	0
Museums, Report on Provincial, 1887	5	0	0
„ in relation to Education, 1914–20 ...	74	5	0
Number, Distribution, and Value of Scholarships, Exhibitions, and Bursaries at Universities, 1915	3	2	8

	£	s.	d.
Overlapping between Secondary and Higher Education, 1912	1	18	6
Pictures, Educational, for use in Schools, 1920 ...	10	0	0
Science Teaching in Secondary Schools, 1917–18	12	4	10
State of Schools in England, 1838–42	150	0	0
Statistical Inquiries in Schools for the Working Classes, 1840	50	0	0

Section M.—Agriculture

Reprint of Discussion on Relationship of Agriculture to Science, 1896	5	0	0

APPENDIX II

(1) Dates and Places of Annual Meetings, with Biographical Notes on Presidents of the Association (in Chronological Order).

1831, York.—Charles William Wentworth Fitzwilliam, Viscount Milton (1786–1857), 3rd Earl Fitzwilliam (1833); F.R.S.; M.P. for Yorkshire, 1807–31; K.G., 1851; supporter of parliamentary reform and free trade.

1832, Oxford.—Rev. William Buckland (1784–1856), F.R.S., professor of mineralogy, 1813–56, and geology, 1818–56, at Oxford; canon of Christ Church, Oxford, 1825; dean of Westminster, 1845–56; president, Geological Soc., 1824, 1840.

1833, Cambridge.—Rev. Adam Sedgwick (1785–1873), F.R.S., Woodwardian professor of geology, Cambridge, 1818–73; president, Geological Soc., 1831; prebendary of Norwich, 1834.

1834, Edinburgh.—Sir Thomas Makdougall Brisbane (1773–1860), F.R.S.; K.C.B., 1814; Bart., 1836; G.C.B., 1837; General, 1841; saw military service in West Indies, Peninsula, Canada, etc.; maintained observatory at Brisbane, Scotland; founded observatory at Parramatta while governor of New South Wales, 1821–25; built astronomical and magnetic observatory at Makerstoun, Scotland, c. 1840; president, Royal Soc. Edin., 1833–60.

1835, Dublin.—Rev. Bartholomew Lloyd (1772–1837), F.R.S., of Trinity Coll., Dublin: Erasmus Smith's professor of mathematics, 1813; regius professor of Greek, 1821, 1823, 1825; Erasmus Smith's professor of natural and experimental philosophy, 1822; provost, 1831–37; president, Royal Irish Academy, 1835.

1836, Bristol.—The Marquis of LANSDOWNE (1780–1863), F.R.S. [Sir Henry Petty-Fitzmaurice, 3rd Marquis, 1809]; M.P., 1803 *seqq.*; Chancellor of the Exchequer, 1806; minister without portfolio, 1827–28; lord president of the council at intervals 1830–41 and 1846–52; a whig in politics; active promoter of abolition of slave trade, etc.

1837, Liverpool.—The Earl of BURLINGTON (1808–99), F.R.S. [William Cavendish, 2nd Earl, 1834, 6th Duke of Devonshire, 1858]; M.P. for Cambridge Univ., 1829; chancellor of the Univ. of London, 1836–56; Cambridge, 1861–91; president, Iron and Steel Inst., 1868; Roy. Agric. Soc., 1870; chairman, Royal Commission on scientific instruction and advancement of science; promoter of iron and steel works, Barrow-in-Furness, etc.; benefactor of Yorkshire College of Science and Owens College, Manchester.

1838, Newcastle-on-Tyne.—The Duke of NORTHUMBERLAND (1785–1847), F.R.S. [Sir Hugh Percy, 3rd Duke, 1817]; M.P., 1806 *seqq.*; K.G., 1819; governor, King's College, London, 1831; chancellor, Cambridge Univ., 1840–47.

1839, Birmingham.—Rev. William Vernon HARCOURT (1789–1871), F.R.S.; entered navy in early life; canon of York, 1824; constructed chemical laboratory and worked with Davy and others; general secretary, B.A., 1832–37.

1840, Glasgow.—John Campbell, 2nd Marquis of BREADALBANE (1796–1862), F.R.S.; M.P. as Viscount Glenorchy, 1820–26, as Earl of Ormelie, 1832; succeeded to marquisate 1834; lord rector of Glasgow Univ., 1843.

1841, Plymouth.—Rev. William WHEWELL (1794–1866), F.R.S.; of Cambridge Univ.: professor of mineralogy, 1828–32; Knightbridge professor of moral philosophy, 1838–55; master of Trinity Coll., 1841–66; vice-chancellor, 1843, 1856; instrumental in founding Whewell professorship of international law, moral sciences tripos, and natural sciences tripos.

1842, Manchester.—Lord Francis EGERTON (1800–57), F.R.S.; M.P., 1822 *seqq.*; P.C., 1828; secretary at war, 1830; Viscount Brackley and Earl of Ellesmere, 1846; writer and translator of poetry; archaeologist; early

supporter of London Univ.; president of various learned societies.

1843, Cork.—The Earl of Rosse (1800–67), F.R.S. [William Parsons, 3rd Earl, 1841]; M.P., 1823–34; began experiments for improvement of reflecting telescope, 1827; completed great astronomical telescope at Parsonstown, Ireland, 1845; president, Royal Soc., 1848–54; chancellor, Dublin Univ., 1862.

1844, York.—Rev. George Peacock (1791–1858), F.R.S.; of Cambridge Univ.: lecturer in mathematics, Trinity Coll., 1815; Lowndean professor of astronomy, 1837–58; associated with Herschel, Babbage, and others in introducing analytical methods in mathematics; dean of Ely, 1839–58.

1845, Cambridge.—Sir John Frederick William Herschel (1792–1871), Bart., 1838; F.R.S.; fellow of St. John's Coll., Cambridge, 1816; secretary, Royal Soc., 1824–27; president, Royal Astronomical Soc., 1827–32; made important astronomical observations at Cape of Good Hope, 1834–38; Royal Commission on Standards, 1838–43; lord rector, Aberdeen Univ., 1842; master of the Mint, 1850–55.

1846, Southampton.—Sir Roderick Impey Murchison (1792–1871), Kt., 1846; K.C.B., 1863; Bart., 1866; F.R.S.; served in army, 1807–14, and saw action in Peninsular war, etc.; president, Geological Soc., 1831; Royal Geographical Soc., 1843–58; director-general, Geological Survey, 1855.

1847, Oxford.—Sir Robert Harry Inglis (1786–1855), Bart., 1820; F.R.S.; M.P., 1824 *seqq.* (for Oxford Univ., 1829–54); P.C., 1854; opponent of parliamentary reform, repeal of corn laws, etc.

1848, Swansea.—The Marquis of Northampton (1790–1851), F.R.S. [Spencer Joshua Alwyne Compton, 2nd Marquis, 1828]; M.P. (as Earl Compton), 1812–20; president, Geological Soc., and of Royal Soc., 1838–48; whig; writer of verse.

1849, Birmingham.—Rev. Thomas Romney Robinson (1792–1882), F.R.S.; astronomer; deputy-professor of natural philosophy, Trinity Coll., Dublin, 1814; director

of Armagh Observatory, 1823; rector of Carrickmacross, 1824–82; president, Royal Irish Academy, 1851–56; inventor of cup-anemometer.

1850, Edinburgh.—Sir David BREWSTER (1781–1868), F.R.S.; licensed preacher, 1804; editor, *Edinburgh Magazine* (later *Philosophical Journal*, and *Journal of Science*), 1802 *seqq.*; editor, Edinburgh Encyclopædia (1807–29); first director, Royal Scottish Soc. of Arts, 1821; Kt., 1821; principal, Colls. of St. Salvator and St. Leonard, St. Andrews Univ., 1838; vice-chancellor, Edinburgh Univ., 1860; president, Royal Soc. Edinburgh, 1864; optical investigations; discoveries in polarisation of light; invention of kaleidoscope.

1851, Ipswich.—[Sir] George Biddell AIRY (1801–92), F.R.S., Lucasian professor of mathematics, Cambridge Univ., 1826; Plumian professor of astronomy and director of observatory, *ibid.*, 1828; astronomer-royal, 1835–81; president, Royal Astron. Soc., 1835–37, 1849–51, 1853–55, 1863–64; president, Royal Soc., 1871–73; K.C.B., 1872.

1852, Belfast.—[Sir] Edward SABINE (1788–1883), F.R.S.; saw active service in N. America, 1814; Lieut.-Colonel, 1851; General, 1870; astronomer on Arctic expeditions of Ross and Parry, 1818–20; voyages for experiments on terrestrial magnetism, 1821, 1823; magnetic survey of British Isles, 1834–36, 1861; superintended system of magnetic observations in the Empire; general secretary, B.A., 1839–52, 1853–59; president, Royal Soc., 1861–71; K.C.B., 1869.

1853, Hull.—William HOPKINS (1793–1866), F.R.S., mathematician and geologist; coach at Cambridge; investigated movement of glaciers, condition of interior of the earth, etc.; president, Geological Soc., 1851; general secretary, B.A., 1861–65.

1854, Liverpool.—The Earl of HARROWBY (1798–1882), F.R.S. [Dudley Ryder, 2nd Earl, 1847]; M.P., 1819 *seqq.*; chancellor, Duchy of Lancaster, 1855; P.C., 1855; lord privy seal, 1855–57; K.G., 1859.

1855, Glasgow.—The Duke of ARGYLL (1823–1900),

F.R.S. [George Douglas Campbell, Marquis of Lorne, 1837; 8th Duke of Argyll, 1854]; lord privy seal, 1853 *seqq.*; postmaster general, 1855–58, 1860; secretary for India, 1868–74; whig; K.T., 1856; K.G., 1883; chancellor, St. Andrews Univ., 1851; lord rector, Glasgow Univ., 1854; geologist of catastrophic school; opponent of Charles Darwin.

1856, Cheltenham. — Charles Giles Bridle DAUBENY (1795–1867), F.R.S.; of Oxford Univ.: professor of chemistry, 1822–55; botany, 1834; rural economy, 1840.

1857, Dublin.—Rev. Humphrey LLOYD (1808–81), F.R.S.; of Trinity Coll., Dublin: Erasmus Smith's professor of natural and experimental philosophy, 1831–43; provost, 1867; president, Royal Irish Academy, 1846–51; investigations in optics and magnetism.

1858, Leeds.—[Sir] Richard OWEN (1804–92), F.R.S.; naturalist; assistant, joint-conservator, and conservator, Hunterian Museum, 1827–56; superintendent, Natural History Museum, 1856–83; first president, Microscopical Soc., 1840; K.C.B., 1884.

1859, Aberdeen.—H.R.H. Albert Francis Charles Augustus Emmanuel, PRINCE CONSORT (1819–61), F.R.S.; son of Ernest, Duke of Saxe-Coburg-Gotha; married Queen Victoria, 1840.

1860, Oxford.—Lord WROTTESLEY (1798–1867), F.R.S. [Sir John Wrottesley, 2nd Baron, 1841]; president, Royal Astronomical Soc., 1841–43; Royal Soc., 1854–58; erected astronomical observatory at Blackheath.

1861, Manchester.—[Sir] William FAIRBAIRN (1789–1874), F.R.S.; civil engineer; president, Institute of Mechanical Engineers, 1854; Bart., 1869.

1862, Cambridge.—Rev. Robert WILLIS (1800–75), F.R.S.; civil engineer; Jacksonian professor of natural and experimental philosophy, Cambridge, 1837–75.

1863, Newcastle-on-Tyne.—Sir William George [Lord] ARMSTRONG (1810–1900), F.R.S.; Kt., 1859; Baron, 1887; president, Inst. Civil Engineers, 1882; construction of guns, warships, etc.

1864, Bath.—Sir Charles Lyell (1797–1875), F.R.S.; Kt., 1848; Bart., 1864; professor of geology, King's Coll., London, 1831–33; president, Geological Soc., 1835, 1849.

1865, Birmingham.—John Phillips (1800–74), F.R.S., professor of geology, Trinity Coll., Dublin, 1844–53; keeper of Ashmolean and University Museums, 1854–74; professor of geology, Oxford Univ., 1856–74; president, Geological Soc., 1859–60; secretary, B.A., 1831, assistant general secretary, 1832–62.

1866, Nottingham.—[Sir] William Robert Grove (1811–1896), F.R.S.; Kt., 1871; P.C., 1887; physicist and lawyer; judge of Court of Common Pleas, 1871, and of Queen's Bench, 1880.

1867, Dundee.—Duke of Buccleuch (1806–84), F.R.S.; P.C., 1842 [Walter Francis Scott, 5th Duke, 1819]; lord privy seal, 1842–46; chancellor, Glasgow Univ., 1877.

1868, Norwich.—[Sir] Joseph Dalton Hooker (1817-1911), F.R.S.; K.C.S.I., 1877; G.C.S.I., 1897; assistant director, Kew Gardens, 1855–65; director, 1865–85; president, Royal Soc., 1873–78.

1869, Exeter.—[Sir] George Gabriel Stokes (1819-1903), F.R.S.; Bart., 1889; Lucasian professor of mathematics, Cambridge, 1849; master of Pembroke Coll., Cambridge, 1902; M.P. for Cambridge Univ., 1887–91; president, Royal Soc., 1885–90; researches on wave motion, etc.

1870, Liverpool.—Thomas Henry Huxley (1825–85), F.R.S.; P.C., 1882; biologist; Hunterian professor, Royal Coll. of Surgeons, 1863–69; Fullerian professor, Royal Inst., 1863–67; rector, Aberdeen Univ., 1872–74; president, Royal Soc., 1883–85.

1871, Edinburgh.—Sir William Thomson (1824–1907), F.R.S. [Kt., 1866; Baron Kelvin of Largs, 1892]; G.C.V.O., 1896; O.M., 1902; professor of natural philosophy, Glasgow Univ., 1846–99; president, Royal Soc., 1890–95.

1872, Brighton.—William Benjamin Carpenter (1813–1885), F.R.S.; C.B., 1879; Fullerian professor of physiology, Royal Inst., 1844; professor of forensic medicine, Univ.

Coll., London, 1849; registrar, London Univ., 1856–79; botanist, zoologist, and physiologist.

1873, Bradford.—Alexander William WILLIAMSON (1824–1904), F.R.S., professor of chemistry, Univ. Coll., London, 1855–87; president, Chemical Soc., 1863–65, 1869–71; researches on gas, ether, atomic theory, etc.

1874, Belfast.—John TYNDALL (1820–93), F.R.S., professor of natural philosophy, Royal Inst., 1853–87, and superintendent from 1867; researches in molecular physics, radiant heat, etc.

1875, Bristol.—Sir John HAWKSHAW (1811–91), F.R.S.; Kt., 1873; president, Inst. of Civil Engineers, 1862 and 1863; railway constructor, builder of Severn tunnel, etc.

1876, Glasgow.—Thomas ANDREWS (1813–85), F.R.S., professor of chemistry, Queen's Coll., Belfast, 1849–79.

1877, Plymouth.—Allen THOMSON (1809–84), F.R.S., professor of physiology, Edinburgh Univ., 1842–48; professor of anatomy, Glasgow Univ., 1848–77.

1878, Dublin.—William SPOTTISWOODE (1825–83), F.R.S.; Queen's printer, 1846; president, Royal Soc., 1878–83; researches in polarisation of light, electric discharges in rarified gas, etc.

1879, Sheffield.—George James ALLMAN (1812–98), F.R.S., regius professor of natural history, Edinburgh Univ., 1855–70; president, Linnean Soc., 1874–83.

1880, Swansea.—[Sir] Andrew Crombie RAMSAY (1814–1891), F.R.S., Kt., 1881; professor of geology, Univ. Coll., London, 1847; president, Geological Soc., 1862–64; director-general, Geological Survey, 1871.

1881, York.—Sir John LUBBOCK (1834–1913), F.R.S. [3rd Bart., 1865; Baron Avebury, 1900]; first president, Inst. of Bankers, 1879; vice-chancellor, London Univ., 1872–80; president, Linnean Soc., 1881–86; president, London Chamber of Commerce, 1888–92; chairman, London County Council; researches in anthropology, etc.

1882, Southampton.—[Sir] Charles Williams SIEMENS (1823–83), F.R.S.; Kt., 1883; president, Inst. of Mechanical Engineers, 1872; researches in applied electricity, etc.

1883, Southport.—Arthur CAYLEY, (1821–95), F.R.S., Sadleirian professor of pure mathematics, Cambridge Univ., 1863–95; president, Royal Astron. Soc., 1872–74; barrister.

1884, Montreal.—Lord RAYLEIGH (1842–1919) [John William Strutt, 3rd Baron, 1873], F.R.S.; O.M., 1902; P.C., 1905; Cavendish professor of experimental physics, Cambridge Univ., 1879–84; professor of natural philosophy, Royal Inst., 1888–1905; president, Royal Soc., 1905–08; chancellor, Cambridge Univ., 1908.

1885, Aberdeen.—Sir Lyon PLAYFAIR (1818–98), [Baron Playfair of St. Andrews, 1892]; F.R.S.; C.B., 1851; K.C.B., 1883; G.C.B., 1895; president, Chemical Soc., 1857–59; professor of chemistry, Edinburgh Univ., 1858–69; M.P. for Edinburgh Univ., 1868–85; postmaster-general, 1873; chairman and deputy speaker to House of Commons, 1880–83; lord-in-waiting to Queen Victoria, 1892; took leading part in organisation of Victoria and Albert Museum.

1886, Birmingham.—Sir John William DAWSON (1820–1899), F.R.S.; C.M.G., 1882, Kt., 1884; professor of geology and principal of McGill Coll. and Univ., Montreal, 1855–93; first president of Royal Soc. of Canada; president, American Assoc., 1884; president, American Geological Soc., 1893.

1887, Manchester.—Sir Henry Enfield ROSCOE (1882–1915), F.R.S.; Kt., 1884; professor of chemistry, Owens Coll., Manchester, 1858–86; M.P., 1885–95; president, Chemical Soc., 1880; Soc. of Chemical Industry, 1881; vice-chancellor, London Univ., 1896–1902.

1888, Bath.—Sir Frederick Joseph BRAMWELL (1818–1903), F.R.S.; Kt., 1881; Bart., 1889; president, Inst. of Civil Engineers, 1874.

1889, Newcastle-on-Tyne.—[Sir] William Henry FLOWER (1831–99), F.R.S.; C.B., 1887; K.C.B., 1892; Hunterian professor of comparative anatomy and physiology, 1870–84; president, Zoological Soc., 1879–99; president, Anthropological Inst., 1883–85; director of Natural History Museum, 1884–98.

1890, Leeds.—Sir Frederick Augustus Abel (1827–1902), F.R.S.; C.B., 1877; K.C.B., 1883; Bart., 1893; organising secretary and first director to Imperial Inst., 1887–1902; president, Iron and Steel Inst., 1891–93; researches on explosives.

1891, Cardiff.—[Sir] William Huggins (1824–1910), F.R.S.; K.C.B., 1897; O.M., 1902; president, Royal Astronomical Soc., 1876–78; president, Royal Soc., 1900–05.

1892, Edinburgh.—Sir Archibald Geikie (1835 – —), F.R.S.; Kt., 1891; K.C.B., 1907; O.M., 1914; director, Geological Survey of Scotland, 1867; first Murchison professor of geology and mineralogy, Edinburgh Univ., 1871–82; director-general, Geological Survey of United Kingdom, 1882–1901; president, Geological Soc., 1891–92, 1906–08; president, Royal Soc., 1908–13.

1893, Nottingham.—[Sir] John Scott Burdon-Sanderson (1828–1905), F.R.S.; Bart., 1899; Jodrell professor of physiology, Univ. Coll., London, 1874–82; Waynflete professor of physiology, Oxford Univ., 1883–95; regius professor of medicine, Oxford Univ., 1895–1904.

1894, Oxford.—Robert Arthur Talbot Gascoigne-Cecil, Marquis of Salisbury (1830–1903), F.R.S.; K.G.; [Marquis, 1868]; secretary of state for India, 1866 and 1874; chancellor of Oxford Univ., 1869; prime minister and secretary of state for Foreign Affairs, 1885, 1886–92, 1895–1900; prime minister, 1900–02.

1895, Ipswich.—Sir Douglas Strutt Galton (1822–99), F.R.S.; C.B., 1865; K.C.B., 1887; assistant permanent under-secretary for war, 1862–69; director of public works and buildings, 1869–75; president of Senate of Univ. Coll., London; authority on education, sanitation, etc.

1896, Liverpool.—Sir Joseph Lister (1827–1912), F.R.S.; Bart., 1883; created Baron Lister of Lyme Regis, 1897; O.M., 1902; professor of clinical surgery, Edinburgh Univ., 1869, and King's Coll., London, 1877; president, Royal Soc., 1895–1900; discoveries in surgical antisepsis, etc.

1897, Toronto.—Sir John Evans (1823–1908), F.R.S.; K.C.B., 1892; president, Soc. of Antiquaries, 1885–92;

president, Numismatic Soc., 1874–1908; president, Geological Soc., 1874–76; president, Anthropological Inst., 1877–79; president, Soc. of Chemical Industry, 1892–93.

1898, Bristol.—Sir William CROOKES (1832–1919), F.R.S.; K.C.B., 1897; superintendent, Meteorological Department, Radcliffe Observatory, 1854; editor, *Quarterly Journal of Science*, 1864; president, Royal Soc., 1913–15; discoveries in molecular physics, etc.

1899, Dover.—Sir Michael FOSTER (1836–1907), F.R.S.; K.C.B., 1899; professor of practical physiology, Univ. Coll., London, 1869; professor of physiology, Cambridge Univ., 1883–1903; M.P. for Univ. of London, 1900–06.

1900, Bradford.—Sir William TURNER (1832–1916), F.R.S.; Kt., 1886; professor of anatomy, Edinburgh Univ., 1867; principal and vice-chancellor, Edinburgh Univ., 1903; president, General Medical Council, 1898–1904; president, Royal Soc. Edin., 1908.

1901, Glasgow.—[Sir] Arthur William RÜCKER (1848–1915), F.R.S.; Kt., 1902; principal, London Univ., 1901–1908; president, Physical Soc., 1893–95; magnetic survey of United Kingdom, etc.

1902, Belfast.—[Sir] James DEWAR (1842 – —), F.R.S.; Kt., 1904; Jacksonian professor of experimental philosophy, Cambridge Univ.; Fullerian professor of chemistry, Royal Institution; director, Davy-Faraday Research Laboratory.

1903, Southport.—Sir Joseph Norman LOCKYER (1836–1920), F.R.S.; K.C.B., 1897; director Solar Physics Observatory, Royal Coll. of Science.

1904, Cambridge.—Rt. Hon. Arthur James BALFOUR (1848 – —), F.R.S.; P.C., 1885; O.M., 1916; K.G. and earldom, 1922; M.P., 1874 *seqq.*; president, Local Government Board, 1885–6; Secretary for Scotland, 1886–7; Chief Secretary for Ireland, 1887–91; First Lord of the Treasury, 1891–92, 1895–1906; Prime Minister, 1902–05; First Lord of the Admiralty, 1915–16; Foreign Secretary, 1916–19.

1905, South Africa.—[Sir] George Howard DARWIN (1845–1912), F.R.S.; K.C.B., 1905; second son of Charles Robert Darwin; Plumian professor of astronomy,

Cambridge Univ., 1883–1912; president, Royal Astron. Soc., 1899–1900.

1906, York.—[Sir] Edwin Ray LANKESTER (1847 – —), F.R.S.; K.C.B., 1907; professor of zoology and comparative anatomy, Univ. Coll., London, 1874–90; regius professor of natural history, Edinburgh Univ., 1882; Linacre professor of comparative anatomy, Oxford Univ., 1891–98; Fullerian professor of physiology and comparative anatomy, Royal Institution, 1898–1900; director, Natural History Museum, 1898–1907.

1907, Leicester.—Sir David GILL (1843–1914), F.R.S.; K.C.B., 1900; H.M. astronomer at Cape of Good Hope, 1879–1906; president, Royal Astron. Soc., 1909–11.

1908, Dublin.—[Sir] Francis DARWIN (1848 – —), F.R.S.; Kt., 1913; third son of Charles Robert Darwin, whose assistant he became; published memoirs of Darwin, papers on physiological botany, and other botanical works.

1909, Winnipeg.—Sir Joseph John THOMSON (1856– —), F.R.S.; Kt., 1908; O.M.; Cavendish professor of experimental physics, Cambridge Univ., 1884–1918; professor of physics, Royal Institution, 1905; master of Trinity Coll., Cambridge, 1918; president, Royal Soc., 1915–20.

1910, Sheffield.—Rev. Thomas George BONNEY (1833– —), F.R.S.; emeritus professor of geology, Univ. Coll., London; hon. canon of Manchester; secretary, B.A., 1881–85; president, Geological Soc., 1884–86.

1911, Portsmouth.—Sir William RAMSAY (1852–1916), F.R.S.; K.C.B., 1902; principal, Univ. Coll., Bristol, 1881; professor of chemistry, Univ. Coll., London, 1887–1913.

1912, Dundee.—[Sir] Edward Sharpey SCHAFER (1850– —), F.R.S.; Kt., 1913; professor of physiology, Edinburgh Univ., 1899; general secretary, B.A., 1895–1900.

1913, Birmingham.—Sir Oliver Joseph LODGE (1851– —), F.R.S.; Kt., 1902; professor of physics, Univ. Coll., Liverpool, 1881–1900; principal, Birmingham Univ., 1900–19; president, Physical Soc., 1899–1900; president, Soc. for Psychical Research, 1901–04.

1914, Australia.—William BATESON (1861 – —), F.R.S.;

director, John Innes Horticultural Institution, 1910; Fullerian professor of physiology, Royal Institution, 1912–14.

1915, Manchester.—[Sir] Arthur SCHUSTER (1851 – —), F.R.S.; Kt., 1920; professor of physics, Manchester Univ., 1888–1907.

1916, Newcastle-on-Tyne.—Sir Arthur EVANS (1851 – —), F.R.S.; Kt., 1911; keeper of Ashmolean Museum, Oxford, 1884–1908; honorary keeper, 1908; extraordinary professor of prehistoric archaeology, 1909; archaeological investigations in Crete, etc.

1919, Bournemouth.—Hon. Sir Charles Algernon PARSONS (1854 – —), F.R.S.; C.B., 1904; K.C.B., 1911; inventor of the steam turbine; chairman of electrical and engineering works, Newcastle-on-Tyne, Parsons Marine Steam Turbine Co.

1920, Cardiff.—[Sir] William Abbott HERDMAN (1858– —), F.R.S.; Kt., 1922; professor of natural history, Liverpool Univ., 1881–1919; professor of oceanography, *ibid.*, 1919–20; president, Linnean Soc., 1904–08; general secretary, B.A., 1903–19.

1921, Edinburgh.—Sir Edward THORPE (1845 – —), F.R.S.; C.B., 1900; Kt., 1909; professor of chemistry, Andersonian Institute, 1870; Yorkshire Coll. of Science, Leeds, 1874; Royal Coll. of Science, London, 1885; emeritus professor of general chemistry, Imperial Coll. of Science, and Technology; formerly director, Government laboratories.

1922, Hull.—Sir Charles Scott SHERRINGTON, G.B.E., president-elect; president, Royal Soc.; Waynflete professor of physiology, Oxford Univ.

(2) ADDITIONAL BIOGRAPHICAL NOTES

ADAMS, John Couch (1819–92), F.R.S., fellow of St. John's and Pembroke Coll., Cambridge, 1853–92; discoverer of planet Neptune, 1841–47; Lowndean professor of astronomy and geometry, Cambridge, 1859; director of observatory at Cambridge, 1861–92; president, Royal Astronomical Soc., 1851–53, 1874–76.

ADARE : see DUNRAVEN.

ADDERLEY, Sir Charles Bowyer [Lord Norton] (1814–1905), P.C., 1858 ; K.C.M.G., 1869 ; created Baron Norton, 1878 ; M.P. for N. Staffordshire, 1841–78 ; vice-president of Education Committee, Privy Council, and president of Board of Health, 1858–59 ; under-secretary for Colonies, 1866–68 ; president of Board of Trade, 1874–78. Social reform, education and Colonial affairs.

AGARDH, Carl Adolf (1785–1859), professor of botany and rural economy, Lund, Sweden, 1812 ; ordained, 1816, and bishop of Karlstad, Sweden, 1834. Leading member of Diet.

AGASSIZ, Louis Jean Rodolphe (1807–73), professor of natural history, Neuchâtel, 1832–46 ; professor of natural history, Harvard Univ., 1848–73.

ARAGO, Dominique François Jean (1786–1853), professor of analytical geometry and geodesy, Ecole Polytechnique, 1809 ; director of the observatory, Paris, 1830 ; member of Chamber of Deputies, 1830–48 ; member of Provisional Government, 1848 ; minister of War and Navy. Discoveries in polarisation of light and electro-magnetism.

AYRTON, William Edward (1847–1908), F.R.S. ; professor of physics and telegraphy, Imperial Engineering Coll., Tokio, 1873–78 ; professor of applied physics and electrical engineering, Central Technical Coll., S. Kensington, 1884–1908.

BABBAGE, Charles (1792–1871), F.R.S. ; took part in foundation of Astronomical Soc., 1820 ; principal founder of Statistical Soc., 1834 ; Lucasian professor of mathematics, Cambridge Univ., 1828–39 ; trustee, B.A., 1832–39. Invented calculating machine.

BABINGTON, Charles Cardale (1808–95), F.R.S. ; botanist and archaeologist ; a founder of the Entomological Soc., 1833 ; professor of botany, Cambridge, 1861–95.

BACHE, Alexander Dallas (1806–67), professor of natural philosophy and chemistry, Pennsylvania Univ., 1828–41 ; president, American Association.

BAILY, Francis (1774–1844), F.R.S. ; after early work as stockbroker, etc., became interested in astronomy, 1820 ;

a founder of the Royal Astronomical Soc., and president, 1825–27, 1833–35, 1837–39, 1843–45; reviser of star catalogues; reformed Nautical Almanac; trustee, B.A., 1839–44.

Baker, Sir Samuel White (1821–93), F.R.S., explorer of Nile headwaters and tributaries, 1861–65; Kt., 1866; governor-general, Upper Nile region, 1869–73.

Balfour, Francis Maitland (1851–82), F.R.S., special professor of animal morphology, Cambridge Univ., 1882; general secretary, B.A., 1881–82. Accidental death while mountaineering in Switzerland.

Ball, Sir Robert Stawell (1840–1913), F.R.S., director of Science and Art Museum, Dublin, 1868; Royal Astronomer of Ireland, 1874–92; Lowndean professor of astronomy and geometry, and director of observatory, Cambridge, 1892; Kt., 1886.

Bent, James Theodore (1852–97), archaeological researches in Asia Minor, 1888, etc.; Bahrein Islands, 1889; Abyssinia, 1893; Arabia, 1893–97.

Bessel, Friedrich Wilhelm (1784–1846), director of observatory, Königsberg, 1810, and professor of astronomy.

Bessemer, Sir Henry (1813–98), F.R.S., patented method of manufacturing steel, 1855 *seqq.*; established steel works at Sheffield, 1859; Kt., 1879.

Bradley, Rev. James (1693–1762), F.R.S.; Savilian professor of astronomy, Oxford Univ., 1721–62, and first reader in experimental philosophy, 1749–62; astronomer royal, 1742–62; discoverer of aberration of light.

Bright, Sir Charles Tilston (1832–88), telegraph engineer, engaged with Thomson (Kelvin) in laying of first Atlantic cable, Valentia–Newfoundland, 1858; Kt., 1858; M.P., 1865.

Broderip, William John (1789–1859), F.R.S., barrister; magistrate, 1822–56; zoologist; a founder of Zool. Soc., 1826.

Brown, Robert (1773–1858), F.R.S., researches in botany.

Bruce, William Speirs (1867–1922), director, Scottish

Oceanographical Laboratory; naturalist on Scottish Antarctic expedition, 1892–93; Jackson-Harmsworth Arctic expedition, 1895-96; Coats expedition to Novaya Zemlya, etc., 1898; Spitsbergen, 1898 *seqq.*; led Scottish National Antarctic Expedition, 1902–04.

BUNSEN, Robert Wilhelm von (1811–99), professor of chemistry, Marburg, 1836–51; *ibid.*, Heidelberg, 1852–89. Chemical and electrical researches; developed spectrum analysis (with Kirchhoff); invented Bunsen burner.

BURTON, Sir Richard Francis (1821–90), explorations in Arabia, 1853; Somaliland, 1854; Nile sources, 1856–59, etc.; K.C.M.G., 1885.

CAIRD, Sir James Key (1837–1916), Bart., 1913; jute manufacturer, of Dundee; benefactions, estimated to amount in all to £250,000, to city of Dundee, antarctic exploration, British Association, Zoological Society of London, and for other scientific, social, and political purposes.

CARLISLE, Earl of [George William Howard, Viscount Morpeth] (1802–64), P.C., 1835; succeeded as 7th Earl 1848; chief secretary for Ireland, 1835–41; member of Cabinet, 1839; chief commissioner of Woods and Forests, 1846–50; chancellor of Duchy of Lancaster, 1850–52; lord lieutenant of Ireland, 1855–58, 1859–64; rector of Aberdeen Univ., 1853.

CHALLIS, Rev. James (1803–82), F.R.S., Plumian professor of astronomy and experimental philosophy, Cambridge Univ., 1836–82; director of Cambridge Observatory, 1836–61.

CLIFFORD, William Kingdon (1845–79), F.R.S., professor of applied mathematics, University Coll., London, 1871; student of metaphysics.

CONYBEARE, Very Rev. William Daniel (1787–1857), dean of Llandaff, 1845–57; geological researches.

DALTON, John (1766–1844), professor of mathematics and natural philosophy, New Coll., Manchester, 1793–99. Chemical and meteorological researches.

DARWIN, Charles Robert (1809–82), F.R.S., naturalist on H.M.S. *Beagle* in S. America, 1831; first set forth in

writing doctrine of evolution by natural selection, 1844; published *Origin of Species*, 1859.

Davy, [Sir] Humphry (1778-1829), F.R.S.; Kt., 1812; Bart., 1818; professor of chemistry, Royal Inst., 1802; president, Royal Soc., 1820–27. Chemical discoveries and invention of safety lamp.

De la Beche, Sir Henry Thomas (1796–1855), Kt., 1848; director of Geological Survey, 1832; president, Geological Soc., 1847.

Demainbray, Stephen Charles Triboudet (1710–82), tutor to George III when Prince of Wales, 1754; astronomer, Kew Observatory, 1768–82; electrical researches.

Demainbray, Rev. Stephen George Francis Triboudet (1760–1854), son of preceding; astronomer, Kew Observatory, 1782–1840.

Duddell, William du Bois (1872–1917), C.B.E., F.R.S., consulting engineer; president, Röntgen Soc. and Inst. of Electrical Engineers; Admiralty board of invention and research; inventions board, Ministry of Munitions.

Duff, Sir Mountstuart Elphinstone Grant (1829–1906), G.C.S.I. (1886), P.C., F.R.S.; M.P., 1857–81; under-secretary for India, 1868–74, for the colonies, 1880–81; governor of Madras, 1881–86; president, Royal Geographical Soc., 1889–93.

Duncan, Andrew (1773–1832), first professor of medical jurisprudence, Edinburgh Univ., 1807–19; professor of materia medica, Edinburgh Univ., 1821–32.

Dunraven and Mount-Earl, Earl of [Edwin Richard Windham Wyndham-Quin, Viscount Adare] (1812–71), F.R.S.; M.P., 1837–51; succeeded as 3rd Earl (Irish peerage), 1850; created Baron Kenry (U.K.), 1866; Kt. of St. Patrick, 1866; assisted in foundation of Irish Archaeological Soc., 1840, and Celtic Soc., 1845; president, Cambrian Soc., 1849 and 1869; archaeologist.

Egerton, Sir Philip de Malpas Grey (1806–81), F.R.S.; M.P., 1830, 1835–81; trustee, B.A., 1862–81. Palaeontologist.

Ehrenberg, Christian Gottfried (1795–1876), professor

of medicine, Berlin Univ., 1827. Researches on infusoria and microscopic organisms.

ENCKE, Johann Franz (1791–1865), director of Royal Observatory, Berlin, 1825–65. Astronomical researches.

ENNISKILLEN, Earl of [John Willoughby Cole] (1767–1840), M.P. for Co. Fermanagh, 1790–1800, 1800–03; collector of fossil fishes.

ERICHSEN, Sir John Eric (1818–96), F.R.S., of Danish birth; surgeon, University College Hospital, 1848–75; professor of surgery, University College, 1850–66; Bart., 1895.

ERMANN, Georg Adolf (1806–77), professor of physical science, Berlin Univ., 1839. Magnetic investigations.

EVERETT, Joseph David (1831–1904), F.R.S., professor of mathematics, King's Coll., Windsor, N.S., 1859–64; of natural philosophy, Queen's Coll., Belfast, 1867–97.

FARADAY, Michael (1791–1867), F.R.S., professor of chemistry, Royal Inst., 1827. Discoveries in electro-magnetism, etc.

FITZGERALD, George Francis (1851–1901), F.R.S., Erasmus Smith professor of natural and experimental philosophy, Dublin Univ., 1881.

FITZROY, Robert (1805–65), F.R.S., vice-admiral in command of H.M.S. *Beagle* during Charles Darwin's voyage; head of meteorological dept., 1854.

FORBES, Edward (1815–54), F.R.S., professor of botany, King's Coll., London, 1842; president, Geological Soc., 1853; professor of natural history, Edinburgh Univ., 1854. Geologist, botanist, and zoologist.

FORBES, James David (1809–68), F.R.S., professor of natural philosophy, Edinburgh Univ., 1833–59; principal of United Coll., St. Andrews, 1859. Discoveries in heat polarisation and researches in glacial phenomena.

FRANKLAND, Sir Edward (1825–99), K.C.B., 1897; first professor of chemistry, Owens Coll., Manchester, 1851; professor of chemistry, Royal Inst., 1863. Chemical researches, particularly with regard to analysis of water-supplies and the spectrum of gases.

FRASER, Sir Thomas Richard (1841–1920), F.R.S.;

Kt., 1902; professor of materia medica, Edinburgh, 1877–1918, and of clinical medicine, 1888; president, Royal Coll. of Physicians of Edinburgh, 1900–2. Writings on practical medicine.

Galton, Sir Francis (1822–1911), F.R.S.; Kt., 1909; general secretary, Brit. Assoc., 1863–68; instituted anthropometric laboratory, International Health Exhibition, 1884–85. Researches in heredity, psychology, etc. Founded science of eugenics.

Gassiot, John Peter (1797–1877), F.R.S., chairman of Kew Observatory; founder of Royal Soc. Scientific Relief Fund. Researches in electricity.

Glaisher, James (1809–1903), superintendent, Meteorological and Magnetic Dept., Greenwich Observatory; founder of Meteorological Soc.; assisted in initiating Aeronautical Soc. Observations of atmosphere at high altitudes.

Grant, James Augustus (1827–92), saw service in India; with Speke on exploration in east central Africa, 1861–63; C.B., 1866; Abyssinian expedition, 1868; Lieut.-Col., C.S.I., *id.*

Gray, John Edward (1800–75), F.R.S., assistant keeper in zoology, British Museum, 1824; keeper, 1840–74.

Greenough, George Bellas (1778–1855), F.R.S.; M.P., 1807–12; first president, Geological Soc., 1811–13, 1818, and 1833; president, Royal Geographical Soc., 1839–40.

Greg, Robert Philips (1826–1906), on retiring from commerce in Manchester became a scientific collector, especially of mineralogical specimens; a founder and treasurer of Mineralogical Society; researches on meteors, etc.

Hamilton, Sir William Rowan (1805–65), Kt., 1835; professor of astronomy, Dublin Univ., 1827; royal astronomer of Ireland; president, Royal Irish Academy, 1837.

Harcourt, Augustus George Vernon (1834–1919), F.R.S., senior student and demonstrator in chemistry, Christ Church, Oxford; general secretary, B.A., 1883–97.

Harley, Rev. Robert (1828–1910), F.R.S., congregational minister (England and Australia), and mathematician; principal of Huddersfield Coll., 1882–85.

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HARVEY, William Henry (1811–66), colonial treasurer, Cape Town, 1836–42; professor of botany, Dublin, 1856; travelled in S. Africa, India, Australia, and Pacific; works on S. African plants, etc.

HAUGHTON, Rev. Samuel (1821–97), F.R.S., professor of geology, Dublin Univ., 1851–81; M.D., Dublin, 1862; registrar, etc., of medical school; president, Royal Zoological Soc. of Ireland, 1860; do., Royal Irish Academy, 1887.

HENDERSON, Thomas (1798–1844), F.R.S., H.M. astronomer at Cape of Good Hope, 1832–33; astronomer royal for Scotland and professor of practical astronomy, Univ. of Edinburgh, 1834–44.

HENSLOW, Rev. John Stevens (1796–1861), F.R.S., professor of mineralogy, Cambridge Univ., 1822–25; professor of botany, *ibid.*, 1825–32; geologist and biologist; influenced scientific work of Charles Darwin and introduced him to Fitzroy, of H.M.S. *Beagle*.

HERSCHEL, Alexander Stewart (1836–1907), F.R.S., professor of mechanical and experimental physics, Glasgow Univ., 1866–71; first professor of physics and experimental philosophy, Coll. of Science, Newcastle-on-Tyne, 1871–86.

HIRST, Thomas Archer (1830–92), F.R.S.; professor of physics, Univ. Coll., London, 1865; professor of pure mathematics, *ibid.*, 1866–70; director of naval studies, Royal Naval Coll., Greenwich, 1873–83; general secretary, B.A., 1866–71.

HODGKIN, Thomas (1796–1866), curator and pathologist, Guy's Hospital, 1825; a founder of Aborigines Protection Soc., 1838.

HOPKINSON, John (1849–98), F.R.S., consulting electrical engineer and inventor; professor of electrical engineering, King's College, London, 1890.

HUMBOLDT, Friedrich Heinrich Alexander, Baron von (1769–1859), born at Berlin; travelled in Orinoco and Amazon basins, Andes, Mexico, etc., 1799–1804; Siberia, 1829; naturalist, geographer, and meteorologist; author of *Kosmos*, 1845 *seqq*.

HUME, Rev. Abraham (1814–84), F.R.S., vicar of

Vauxhall, Liverpool, 1847; missionary labours in Chile and Peru, 1867; hon. canon of Chester, 1874, and (on creation of Liverpool diocese, 1880) of Liverpool. Antiquary and writer on social subjects.

Hutton, James (1726–97), originated uniformitarian theory of formation of earth's crust, published in *Theory of the Earth*, 1795.

Jacobi, Karl Gustav Jacob (1804–51), professor of mathematics, Königsberg, 1827–42.

Janssen, Pierre Jules César (1824–1907), French astronomer (1824–1907), undertook many scientific missions in different parts of Europe, S. America, Algeria, Asia, and the Pacific, observing solar eclipses, magnetic phenomena, etc.

Jenner, Edward (1749–1823), F.R.S., medical practitioner, discoverer of vaccination, which he first practised in 1796.

Johnston, James Finlay Weir (1796–1855), F.R.S., chemist to Agricultural Soc. of Scotland.

Jones, John Viriamu (1856–1901), F.R.S., first principal, Univ. Coll. of S. Wales, Cardiff, 1883; vice-chancellor of new Welsh Univ., 1893. Electrical and physical standards.

Joule, James Prescott (1818–89), F.R.S., student under Dalton; researches on the mechanical equivalent of heat, conservation of energy, thermo-dynamic properties of solids, etc.

Kater, Henry (1777–1835), F.R.S.; saw military service in India; geodesist; pendulum experiments, researches in telescopy, etc.

Kelland, Philip (1808–79), F.R.S., professor of mathematics, Edinburgh Univ., 1838–79; president, Royal Soc., Edinburgh, 1878.

Kirchhoff, Gustav Robert (1824–87), professor of physics, Heidelberg, 1854; *ibid.*, Berlin, 1875; developed spectrum analysis (with Bunsen). Researches in mathematical physics, electricity, etc.

Kupffer, Adolf Theodor (1799–1865), professor of chemistry, physics, and mineralogy, Kasan Univ., Russia, 1824–28; director of Magnetic and Meteorological Office,

Petrograd, 1843–65. Erected numerous magnetic observatories, etc., in Russia.

LACAILLE, Nicolas Louis de (1713–62), French astronomer, mathematical professor in Mazarin College; astronomical expedition to Cape of Good Hope, 1750; published observations of 10,000 southern stars, 1763, etc.

LALANDE, Joseph Jérôme Lefrançais de (1732–1807), French astronomer; professor of astronomy in Collège de France, 1762–1807; a popular lecturer and voluminous writer.

LEMON, Sir Charles (1784–1824), F.R.S.; M.P., 1807–12, 1830–41, 1852–57; a founder of the Statistical Soc., 1834; president, Royal Geographical Soc. of Cornwall, 1840–50. Botanical collections in Cornwall.

LEVERRIER, Urbain Jean Joseph (1811–77), professor of astronomy, Faculty of Sciences, 1846; member of Legislative Assembly, 1849; director, Paris Observatory, 1854–70, 1873–77. Researches on planets; joint discoverer (by mathematics) of planet Neptune, 1847.

LEVI, Leone (1821–88), commercial jurist, of Italian birth; professor of commercial law, King's Coll., London, 1852. Author of important works on commercial law, British commerce, etc.

LIEBIG, Baron Justus von (1803–73), F.R.S.; created Baron, 1845; professor of chemistry, Giessen Univ., 1824–1852; professor of chemistry, Munich Univ., 1852–73; president of Academy of Sciences, Munich. Researches and discoveries in chemistry, largely agricultural.

LIVINGSTONE, David (1813–73), missionary and African explorer, in Bechuanaland, 1841; Kalahari desert and lake Ngami, 1849; Zambezi river, 1853 *seqq.*; lake Nyasa, 1861; lake Tanganyika, etc., 1867 *seqq.*; joined by H. M. Stanley at Ujiji, 1871.

LUBBOCK, Sir John William (1803–65), F.R.S.; Bart., 1840; first vice-chancellor, London Univ., 1837–42; treasurer, Great Exhibition, 1851; mathematician. Researches in astronomy and tidal observations.

LYNCH, Henry Blosse (1807–73), Indian navy; survey of

Persian Gulf, 1829–32; exploration of Euphrates route to India (with Chesney), 1834–37; service in second Burmese War, 1851–53; C.B., 1853.

MacCullagh, James (1809–47), professor of mathematics, Trinity Coll., Dublin Univ., 1836; professor of natural philosophy, Dublin Univ., 1843.

Mantell, Gideon Algernon (1790–1852), F.R.S., surgeon. Geological researches and publications.

Markham, Sir Clements Robert (1830–1916), F.R.S.; K.C.B., 1896; Arctic expedition, 1850–51; assistant secretary, India Office, 1867–77; president, International Geographical Congress, 1894–99; president, Royal Geographical Soc., 1893–1905.

Matteucci, Carlo (1811–68), professor of physics, Bologna Univ., 1832; do., Ravenna Univ., 1837; do., Pisa Univ., 1840; Senator, 1860; Minister of Public Instruction, 1862. Researches in electricity.

Matthiessen, Augustus (1831–70), F.R.S., chemist and physicist; lecturer on chemistry, St. Mary's Hospital, London, 1862–68; do., St. Bartholomew's Hospital, 1868. Chemical research on constitution of alloys, etc.

Maury, Matthew Fontaine (1806–73), American naval officer; in charge of depôt of charts and instruments, 1841, from which developed U.S. naval observatory and hydrographic office; set on foot international system of oceanic meteorological observation; published *Physical Geography of the Sea,* 1855; supported South in American Civil War, 1861; in service of Emperor of Mexico as emigration commissioner, 1865; professor of meteorology, Virginia Military Institute, 1868.

Maxim, Sir Hiram Stevens (1840–1916), F.R.S., born in U.S.A., came to England, 1881; inventor; maxim gun adopted by British Army, 1889, Navy, 1892; experiments in flying begun, 1889; first aeroplane trials, 1894; Kt. 1901.

Maxwell, James Clerk (1831–79), F.R.S., professor of natural philosophy, Aberdeen, 1856–60; do., King's Coll., London, 1860–65; Cavendish professor of experimental physics, Cambridge, 1871–79. Principal researches

in electricity, molecular science, electro-magnetic theory of light, etc.

MENDEL, Gregor (1822–82), peasant by birth, monk and abbot of Brünn (Austria); studied physiological process of heredity in peas, etc., grown in cloister garden.

MILLER, William Allan (1817–70), professor of chemistry, King's College, London, 1845; experiments in spectrum analysis, especially in relation to astronomy (with Huggins), 1862; assayer to the Royal Mint and Bank of England.

MOLYNEUX, Samuel (1689–1728), F.R.S.; P.C.; M.P., 1715–27; Lord of Admiralty, 1727. Astronomical researches.

MÜLLER, Johannes Peter (1801–58), professor of philosophy, Bonn Univ., 1826–33; professor of anatomy and physiology, Berlin Univ., 1833–58.

NARES, Sir George Strong (1831–1915), F.R.S.; R.N.; commanded H.M.S. *Challenger*, 1873; expedition to Arctic, 1875–76; K.C.B., 1876; vice-admiral, 1892.

NEWTON, Alfred (1829–1907), F.R.S.; professor of zoology and comparative anatomy, Cambridge; travelled in Iceland, Spitsbergen, N. America, etc.; special interest in protection of birds, chairman of close-time committee.

NEWTON, Sir Isaac (1642–1727), F.R.S.; mathematician; astronomer; originator of the conception of universal gravitation; educated at Cambridge; Lucasian professor there, 1669–1702; published *Principia*, 1687; M.P. for Cambridge Univ., 1689, 1701–2; warden, 1696, and master, 1699, of the Mint; president Royal Soc., 1703–27; Kt., 1705.

NORTHCOTE, Sir Stafford Henry, 1st Earl of Iddesleigh (1818–87), 8th Bart., 1851; C.B., 1851; M.P., 1855 *seqq.*; president, Board of Trade, 1866; secretary for India, 1867; chancellor of the Exchequer, 1874–80; created Earl of Iddesleigh and Viscount St. Cyres, 1885; foreign secretary, 1886.

ÖRSTED, Hans Christian (1777–1851), professor of natural philosophy, Copenhagen; discovered effect of wire uniting poles of a voltaic pile upon a magnetic needle, 1820.

Pengelly, William (1812–94), F.R.S., lecturer on geological and mathematical subjects. Special interest in geology of Devonshire and the exploration of Kent's Cavern, Torquay, etc.

Perry, John (1850–1920), F.R.S.; general treasurer, B.A., 1904–20; held professorship of engineering, mathematics, etc., in Japan, 1875–79, City and Guilds Technical Coll., 1881–96, and Royal Coll. of Science. Electrical engineer and inventor, and educational reformer.

Pitt-Rivers, Augustus Henry Lane-Fox (1827–1900), F.R.S., saw service in Crimean War; lieut.-general, 1882; formed collection illustrating evolution of inventions (originating with weapons), presented to Oxford Univ., 1883; archaeologist; explored early sites, especially in Wilts and Dorset.

Playfair, John (1748–1819), minister of Liff and Bervie, 1773–83; professor in natural philosophy, Edinburgh Univ., 1805. Geologist and mathematician.

Potter, Richard (1799–1886), professor of natural philosophy and astronomy, Univ. Coll., London, 1841–43, 1844–65. Researches on mechanics, optics, etc.

Powell, Rev. Baden (1796–1860), F.R.S., Savilian professor of geometry, Oxford Univ., 1827–60; theologian. Researches on optics and radiation.

Preece, Sir William (1834–1913), F.R.S.; K.C.B., 1899; electrician to Post Office, 1877, and chief engineer, 1892–99; president, Inst. Electrical Engineers, 1880 and 1893. Work on telephones and wireless telegraphy.

Pritchard, Rev. Charles (1808–93), F.R.S., Savilian professor of astronomy, Oxford Univ., 1870–93; president, Royal Astron. Soc., 1866–68; noted preacher.

Quetelet, Lambert Adolphe Jacques (1796–1874), professor of mathematics at Athenæum, Brussels, 1819; director of observatory, Brussels, 1828–74; professor of astronomy and geodesy, Brussels, 1836. Statistical and geometrical investigations.

Rankine, William John Macquorn (1820–72), professor of civil engineering and mechanics, Glasgow, 1855; researches in molecular physics.

Regnault, Henri Victor (1810–78), born at Aix-la-Chapelle, professor of chemistry, École Polytechnique, Paris, 1840; professor of physics, Collège de France, 1841; director of porcelain factory, Sèvres, 1854; researches on specific heats of elements during compounds, and on expansion of gases (in laboratory at Sèvres, but his later work in this direction was destroyed during the Franco-Prussian War).

Rennie, Sir John (1794–1874), F.R.S., civil engineer, builder of London Bridge, 1831; engineer to Admiralty; president, Inst. of Civil Engineers, 1845–48.

Rigaud, Stephen Peter (1774–1839), F.R.S., Savilian professor of geometry, Oxford, 1810–27; do. of astronomy, 1827–39.

Robison, Sir John (1778–1843), Kt., 1838; one of the founders of Scottish Soc. of Arts, and president, 1841–42. Inventor.

Rogers, Henry Darwin (1808–66), professor of geology, Pennsylvania Univ., 1835; State geologist of Pennsylvania, 1836–42, 1851–54; regius professor of natural history, Glasgow Univ., 1857–66.

Ronalds, Sir Francis (1788–1873), F.R.S., hon. director and superintendent, Kew Observatory, 1843–52; researches in electricity and meteorology; devised many valuable instruments; Kt., 1871.

Royle, John Forbes (1799–1858), F.R.S.; surgeon, East India Co.; superintendent, Botanic Garden, Saharanpur, 1823–31; professor of materia medica, King's Coll., London; general secretary, B.A., 1850–53.

Russell, John Scott (1808–82), F.R.S.; naval architect; builder of s.s. *Great Eastern.*

Sargant, Ethel (1863–1918), botanist; research on origin of monocotyledons and dicotyledons, etc.; first woman president of a section (K), B.A., 1913; first woman on Council, Linnean Soc.

Schiaparelli, Giovanni Virginio (1835–1910); director of Brera Observatory, Milan, 1862–1900. Astronomical researches.

Schwabe, Samuel Heinrich (1789–1875), German astronomer, of Dessau; carried out observations on sun-spots from 1826, and suggested periodicity of their intensity.

Sclater, Philip Lutley (1829–1913), F.R.S.; secretary, Zoological Soc., 1859–1902.

Scoresby, Rev. William (1789–1857), F.R.S.; served under father, Arctic navigator; vicar of Bradford, 1839–47. Researches in phenomena of Arctic seas.

Sharpey, William (1802–80), F.R.S.; M.D., Edinburgh; joint lecturer on systematic anatomy, Edinburgh, 1832; professor of anatomy and physiology, Univ. Coll., London, 1836–74.

Simpson, Sir James Young (1811–70), professor of midwifery, Edinburgh, 1839; introduced use of chloroform, 1847; researches in and publications on obstetrics and anæsthetics; Bart., 1866.

Smith, Henry John Stephen (1826–83), F.R.S., mathematical tutor, Balliol Coll., Oxford; Savilian professor of geometry, 1860–83.

Smith, William (1769–1839); canal surveyor, 1793 *seqq.*; authority on drainage, irrigation and stratigraphy; 'father' of English stratigraphical geology; first producer of English geological maps.

Sorby, Henry Clifton (1826–1908), F.R.S., researches in microscopic investigation of rocks, crystals and metals; associated with foundation of Sheffield University.

Speke, John Hanning (1827–64), explorer, with Burton in Somaliland, 1854; great lakes of central Africa, 1856 *seqq.*; with Grant in east central Africa, 1861–63, investigating sources of the Nile.

Stewart, Balfour (1828–87), F.R.S.; assistant to Forbes at Edinburgh, 1856; director, Kew Observatory, 1859–71; secretary, Meteorological Committee, 1867–69; professor of natural philosophy, Owens Coll., Manchester, 1870–87. Researches on radiant heat, sun-spots, terrestrial magnetism, etc. A founder of Soc. for Psychical Research.

STRUVE, Friedrich Georg Wilhelm (1793–1864), professor of astronomy, Dorpat Univ., and director, Dorpat Observatory, Russia, 1820–38; director Pulkova Observatory, Russia, 1839–62. Geodetic measurements and astronomical researches.

STURGEON, William (1783–1850), shoemaker by trade; served in army, 1802–20; lecturer in science, East India College, Addiscombe, 1824; inventor of soft-iron electro-magnet, 1823, magneto-electrical machine, electro-magnetic rotary engine, electro-magnetic coil machine, etc.; founder of *Annals of Electricity* (first journal of electricity in England), 1836.

SYKES, Col. William Henry (1790–1872), F.R.S.; M.P., 1857–72; chairman, Board of Directors, East India Co., 1856; lord rector, Marischal Coll., Aberdeen, 1854; president, Royal Asiatic Soc., 1858; president, Statistical Soc., 1863.

SYLVESTER, James Joseph (1814–97), professor of natural philosophy, University Coll., London, 1837–41; of mathematics, Univ. of Virginia, 1841–45; Woolwich, 1855–70; Johns Hopkins Univ., 1877–83; Savilian professor of geometry, Oxford Univ., 1883–97.

TALFOURD, Sir Thomas Noon (1795–1854), M.P., 1835 *seqq.*; sargeant, 1833; justice of the common pleas, 1849; dramatic writer and biographer.

TAYLOR, John (1779–1863), F.R.S., chemical manufacturer and mining engineer; one of the founders of B.A., and of Univ. Coll., London; trustee and general treasurer, B.A., 1832–62.

THOMPSON, Silvanus Phillips (1851–1916), F.R.S., professor of experimental physics, Univ. Coll., Bristol, 1876–1885; principal and professor of physics, City and Guilds Technical Coll., Finsbury, 1885–1916. Researches in optics, electricity, etc.

THOMSON, Sir Charles Wyville (1830–82), F.R.S., professor of natural history, Edinburgh Univ., 1870; organised oceanographical expeditions (north of Scotland, 1868; Mediterranean, 1870; world-expedition on board H.M.S. *Challenger*, 1872–76); Kt., 1876.

Thomson, Thomas (1817–78), F.R.S., curator, Asiatic Society's Museum, Calcutta, 1840; saw active service in Sutlej campaign; botanical researches in India; general secretary, B.A., 1868–72.

Tiedemann, Friedrich (1781–1861), professor of anatomy and zoology, Landshut, 1806; Heidelberg, 1816.

Tylor, Edward Burnett (1832–1917), F.R.S., keeper of Univ. Museum, Oxford, 1883; first professor of anthropology, Oxford Univ., 1896.

Wallace, Alfred Russel (1823–1913), O.M., F.R.S., visited Amazon with Bates, 1848–52; Malay Archipelago, 1854–62; researches in zoology (notably zoogeography), botany, etc.; also on origin of species on parallel lines and contemporaneously with Darwin; voluminous author on these subjects, social science, etc.

Watt, James (1736–1819), F.R.S., early work as maker of scientific instruments; designed condenser and air-pump for steam-engine, 1765; patented his own steam-engine, 1769; subsequently devised many mechanical improvements; canal and harbour surveyor, 1760–74; chemical researches in later life included that on composition of water.

Weber, Wilhelm Eduard (1804–91), German physicist; professor of physics, Univ. of Halle, 1828; Göttingen, 1831–37; Leipzig, 1843–49; Göttingen, 1849–91.

Wheatstone, Sir Charles (1802–75), F.R.S.; Kt., 1868; professor of experimental physics, King's Coll., London, 1844. Experiments on sound and light; work on telegraphy, etc.

White, Sir William (1845–1913), F.R.S.; K.C.B., 1895; naval architect; director of naval construction and assistant controller of the Navy, 1885–1902; president-elect, B.A., 1913, at time of death.

Williams, Charles James Blasius (1805–89), F.R.S., professor of medicine, University College, London, 1839; instrumental in foundation of Brompton consumption hospital, 1841; first president, Pathological Soc., 1846; Lumleian lecturer, 1862.

WOLLASTON, William Hyde (1766–1828), F.R.S.; secretary to Royal Soc., 1804–16; commissioner of Royal Soc. on Board of Longitude, 1818–28. Chemist, physiologist, and physicist.

YOUNG, Thomas (1773–1829), F.R.S.; professor of natural philosophy, Royal Inst., 1801–03; physician to St. George's Hospital, 1811–29. Researches in structure of the eye, etc., and in Egyptology.

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